Time to Get Social:

Adaptive Social Processes in The Daily Lives of Youth

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TIJD OM SOCIAAL TE WORDEN

ADAPTIEVE SOCIALE INTERACTIES
IN DE DAGELIJKSE LEVENS VAN JONGEREN

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Scientific summary

To better understand the development of mental health problems, it is of fundamental importance to focus on both adolescence – as this is the age period where most psychopathology develops – and social processes – as psychological distress is largely interpersonal in nature. In addition, certain parenting styles are strong predictors of both social and mental health outcomes. However, relatively little is known about how these different factors interrelate in adolescent day-to-day life. Within this dissertation, we draw on data collected with the Experience Sampling Method to gain a greater, more ecologically valid insight into the relationship between parenting, social processes, and psychopathology in adolescents.

In Chapter 3, we present the case for why assessments of social processes require a greater consideration of ecological validity – and of daily life. Social cognition assessments in psychosis are discussed, but the arguments posited here are relevant for all types of social assessments in mental health research.

In Chapters 4 to 6, the interrelationships between parenting, psychopathology, and daily-life social interactions are studied in three empirical studies using two large adolescent experience sampling data sets. In Chapter 4, we find how parental care and control are largely related to the experienced quality of daily-life social interactions rather than to its quantity. A similar finding is reported in Chapter 5, where we see consistent associations between the quality of daily-life social interactions and mean psychopathology level – and less consistent relationships between the quantity of social interactions and psychopathology. Finally, in Chapter 6, these relationships are investigated in one comprehensive model, including more specific parenting styles, and daily social interactions in different companies. In this model, paternal autonomy support and an altered quality of daily social interactions have unique associations with psychopathology levels. Taken together, these findings indicate a particular relevance of the quality of day-to-day social interactions for better understanding psychopathological development.

As the social lives of contemporary adolescents are happening largely online as well as offline, in Chapter 7, we assess how adolescents experience online vs. face-to-face social interactions at the moment that they engage in them. We find how participants report more affective benefits when engaging in face-to-face interactions compared to online interactions, and, in contrast to our hypotheses, we report no moderating effects of social resources on the strength of these benefits.

The investigation of adolescents' social lives and their relation with mental health became much more relevant as COVID-19 hit, when restrictions prevented people from interacting with each other. In the last study, presented in Chapter 8,

we investigate differences in young people's mental health and day-to-day social interactions, from before the pandemic to early in the pandemic (May 2020). We find how face-to-face interactions decreased and online interactions increased, but more surprisingly, that general psychopathology levels were lower than expected and that anxiety levels had even decreased. Moreover, the relationship between the quality of social interactions and psychopathology had become stronger during the pandemic, indicating the relevance of high-quality social interaction during times of social deprivation.

In sum, in this thesis, I target the uniquely relevant momentary social interaction to better understand the social development of young people – and to assess when this might go awry. Across all studies, the quality of social interactions seems fundamentally important. Cross-level relationships seem to exist between general parenting perceptions and how social interactions are experienced in the moment, and between those daily-life social experiences and psychopathology levels. Future research should further disentangle these processes longitudinally to gain greater insight into the temporal ordering of these relationships. Finally, for the development of momentary interventions aimed at relieving social distress, a focus on the quality rather than the quantity of social behaviors is likely most helpful.

Wetenschappelijke samenvatting

Om de ontwikkeling van geestelijke gezondheidsproblemen beter te begrijpen, is het van fundamenteel belang om ons te richten op zowel de adolescentie – de periode waarin de meeste psychopathologie zich ontwikkelt – als op sociale processen – gegeven dat psychisch lijden grotendeels interpersoonlijk van aard is. Daarnaast zijn bepaalde ouderschapsstijlen sterke voorspellers van zowel sociale als mentale gezondheidsproblemen. Toch weten we relatief weinig over hoe deze verschillende factoren zich tot elkaar verhouden in de dagelijkse levens van adolescenten. In deze dissertatie maak ik gebruik van data verzameld met de Experience Sampling Method om een beter, meer ecologisch valide inzicht te verkrijgen in de relatie tussen ouderschap, sociale processen, en psychopathologie bij adolescenten.

In Hoofdstuk 3 beargumenteren we waarom metingen van sociale processen meer rekening moeten houden met ecologische validiteit – en met het dagelijks leven. Het meten van sociale cognitie wordt besproken, maar de gepresenteerde argumenten hebben een bredere relevantie voor alle types sociale metingen in geestelijke gezondheidsonderzoek.

In Hoofdstukken 4 tot en met 6 worden de wederzijdse relaties tussen ouderschap, psychopathologie, en sociale interacties in het dagelijks leven onderzocht in drie empirische studies, gebruik makend van twee grote adolescentenstudies met experience sampling-metingen. In Hoofdstuk 4 vinden we hoe ouderlijke zorg en controle meer gerelateerd zijn aan de ervaren kwaliteit van dagelijkse sociale interacties dan aan de kwantiteit daarvan. We rapporteren iets soortgelijks in Hoofdstuk 5, waar we consistente associaties zien tussen de kwaliteit van dagelijkse sociale interacties en een gemiddeld niveau van psychopathologie – en minder consistente relaties tussen de kwantiteit van sociale interacties en psychopathologie. Tenslotte onderzoeken we deze relaties in Hoofdstuk 6 in één overkoepelend model, waar rekening wordt gehouden met specifiekere ouderschapsstijlen en dagelijkse sociale interacties in verschillende types gezelschap. In dit model hebben vaderlijke autonomie-ondersteuning en de kwaliteit van dagelijkse sociale interacties met niet-familieleden unieke associaties met het niveau van psychopathologie. Alles tezamen geven deze bevindingen de unieke relevantie van de kwaliteit van dagelijkse sociale interacties aan voor het beter begrijpen van de ontwikkeling van psychopathologie.

Omdat de sociale wereld van de hedendaagse adolescent grotendeels ook online plaatsvindt, onderzoeken we in Hoofdstuk 7 hoe adolescenten online versus ‘face-to-face’ sociale interacties ervaren op het moment dat ze in interactie zijn. We zien daar hoe deelnemers meer affectieve voordelen rapporteren wanneer ze face-to-face in plaats van online interageren, en in tegenstelling tot sommige theorieën zien we geen modererende effecten van sociale factoren op

de grootte van deze voordelen.

Het onderzoeken van hoe de sociale levens van adolescenten verband houden met hun geestelijke gezondheid is vele malen relevanter geworden tijdens de COVID-19 pandemie, toen afstandsrestricties sociale interactie ernstig bemoeilijkten. In de laatste studie in Hoofdstuk 8 onderzoeken we verschillen in de geestelijke gezondheid en dagelijkse sociale interacties van jonge mensen, tussen de situatie voor de pandemie en bij het begin van de pandemie in mei 2020. We zien hoe face-to-face sociale interacties afnamen en online interacties toenamen, maar verrassend genoeg ook dat algemene psychopathologie-niveaus lager dan verwacht waren en dat angstklachten zelfs hadden afgenomen. De relatie tussen de kwaliteit van sociale interacties en psychopathologie was bovendien sterker geworden tijdens de pandemie, wat de relevantie van kwaliteitsvolle sociale interacties aangeeft wanneer er sprake is van sociale deprivatie.

Concluderend richt ik mij in deze dissertatie op de unieke relevantie van de momentane sociale interactie in het begrijpen van de sociale ontwikkeling van jongeren – en wanneer dit mis dreigt te gaan. Uit alle studies blijkt een goede kwaliteit van sociale interacties van fundamenteel belang. Relaties lijken te bestaan tussen processen op verschillende niveaus, tussen algemene percepties van ouderschap en hoe sociale interacties op het moment zelf worden ervaren, en tussen die dagelijkse sociale ervaringen en het niveau van psychopathologie. Verder onderzoek dat deze processen longitudinaal ontwart, is nodig om meer inzicht te krijgen in de volgorde waarin dit alles gebeurt. Tenslotte is een focus op de kwaliteit in plaats van de kwantiteit van sociaal gedrag waarschijnlijk het meest behulpzaam in de ontwikkeling van momentane interventies die zich richten op het verlichten van sociale problemen.

Chapter 1:

General Introduction

1.1 Importance, relevance, and timeliness of this dissertation

At the time of writing up this doctoral thesis in the fall of 2021, the ideas contained in it have become increasingly important, relevant, and timely. Following the global restrictions that have been implemented during the COVID-19 pandemic, the impact of social distancing guidelines on adolescent mental health has been widely discussed in both media and academic contexts – although with limited consensus on the size and nature of this impact so far. The key assumption underlying these worries has always been true, but, in the past year and a half, has come to the forefront more than ever: We are all social beings, and social interaction is a fundamental requirement for one's well-being. For adolescents in particular, the possibility to interact with peers is crucial for adaptive psychosocial development. In this thesis, I aim to explain, explicate, and explore these notions – with the goal of improving our understanding of the role of social interactions in adolescent well-being. In doing so, I take an explicit focus on day-to-day life.

1.2 Understanding the early development of psychopathology

1.2.1 Psychopathology is prevalent, and usually starts early

In setting the stage for the urgency of this thesis, we also need to acknowledge how mental health disorders are a leading cause of human distress, and are strongly related to mortality (Walker et al., 2015). To effectively treat mental disorders, a good understanding of their development is required. Longitudinal studies provide great opportunities for assessing the development of (mental) health in any population. The Dunedin birth cohort is an example of an incredible feat of such longitudinal research: Out of all the children born in the city of Dunedin, New Zealand, between April 1972 and March 1973, 91% ($n = 1037$) participated in the Dunedin study at age 3 (Poulton et al., 2015). A majority of these participants have continued to participate throughout the previous decades, with 94% of living participants completing the latest questionnaires and diagnostic interviews at age 45 (Caspi et al., 2020) – and as such, the sample of this study comprises almost the full population. Recent results of this study are striking: The majority of the cohort (86%) had, at one point in their lives, developed a mental disorder (Caspi et al., 2020).

Crucially, most participants (59%) had received a first diagnosis by age 18 – highlighting the young age at which most mental health problems develop. More

recent meta-analytic evidence (based on a sample of $n = 708,561$ individuals) also demonstrates how the peak age for developing any mental disorder is quite early, at age 14.5 (Solmi et al., 2021). Although the lifetime prevalence of psychiatric disorders slightly differs across studies (and depends on the methodology used), other large-scale longitudinal work (Beesdo-Baum et al., 2015; Kessler et al., 2005; Ormel et al., 2015) also uniformly highlights both (1) the ubiquitous presence of mental health problems, and (2) adolescence as a critical period for psychopathological development. These results suggest that, if we aim to understand and prevent the development of early psychopathology, a focus on adolescence is necessary.

1.2.2 The need for a transdiagnostic view

This understanding is, however, hampered by the complexity in the manifestation of early mental health problems. Despite youth being a critical period, in young people, the traditional diagnostic demarcation of disorders often does not map onto the clinical reality. When adolescents first develop mental distress, the associated symptom patterns are usually incredibly diffuse and unstable (McGorry et al., 2018). The limited usefulness of traditional diagnostic systems for differentiating psychopathology is also apparent in the high degree of comorbidity usually observed from an early age onwards: About 40% of adolescents meeting criteria for one class of mental disorder also meet the criteria for at least one other class of disorders (Merikangas et al., 2010). One approach to understand the large overlap between disorders has been the proposal of a 'p-factor' of psychopathology (Caspi et al., 2014) – one common factor underlying all types of mental disorder. Evidence for this p-factor has been reported for children and adolescents as well, where substantial covariance exists among different types of symptoms (Allegrini et al., 2020; Murray et al., 2016). In order to understand the development of early mental distress, it might therefore be most useful to focus on the common rather than the specific factors underlying psychopathology.

In line with the importance of these common factors, and the limited usefulness of artificially discrete diagnostic labels, alternative, transdiagnostic psychiatric systems have been proposed, for example, RDoC (Insel et al., 2010) or HiTOP (Kotov et al., 2017). The goal of such transdiagnostic frameworks is to identify those common factors and processes that are involved across different types of psychiatric distress. Much attention in fundamental transdiagnostic research has targeted cognitive and (neuro)biological processes, such as impaired emotion recognition or altered brain functioning. However, based on a review of transdiagnostic research so far, it has been argued that approaches have insufficiently resulted in large theoretical advances and improved clinical

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interventions (Fusar-Poli et al., 2019). As such, an alternative transdiagnostic focus may be warranted. Therefore, we direct our attention in this dissertation to a domain that has received comparatively little attention, despite the fact that it is essential for understanding the development of psychopathology, highly relevant during adolescence, and very feasibly targeted in interventions: The domain of social processes.

1.3 Going social

1.3.1 Psychopathology in the social domain

In the mid-twentieth century, prominent psychologists and psychiatrists already recognized the importance of good interpersonal connections for psychiatric distress. Whereas Freud had largely focused on the individual, scholars such as Erik Erikson (Erikson, 1950), Karen Horney (Horney, 1950), or Harry Stack Sullivan (Sullivan, 1953) reacted to Freud's intrapsychic view by arguing how the social environment plays a crucial role in both contributing to and protecting against the development of psychopathology.

The importance of social factors for well-being is reaffirmed by later research as well. Epidemiological studies consistently find how a strong social network is the most crucial predictor for adequate well-being. For example, results of the Harvard Study of Adult Development – the longest-running longitudinal study in existence – suggest how good relationships with others are most important for later-life happiness (Vaillant, 2002). Moreover, good social relationships have even been demonstrated to be strong predictors of mortality rates, comparable with well-established risk factors such as smoking and alcohol consumption (Holt-Lunstad et al., 2010).

Social processes are, however, not just potent predictors – they are also integral parts of adaptive functioning. Some types of problems in interpersonal settings can be classified as specific symptoms, for example, social anhedonia, social anxiety, or paranoid ideation. Within diagnostic manuals, however, social functioning is also considered as a separate well-being outcome, relevant across the entire spectrum of psychiatric disorders. Lower social functioning is reported for virtually every type of mental disorder, be it depression (Hirschfeld et al., 2000), anxiety (Saris et al., 2017), or psychosis (Addington et al., 2003).

Most definitions of social functioning focus largely on social behaviors, as social functioning measures inquire about the time that people spend alone, or about the level of involvement with different types of others. For example, in the 'Global Functioning: Social' scale (Cornblatt et al., 2007) that is specifically targeted at mid-adolescents to young adults, higher social functioning scores are given when young people have more social interactions with family members, close friends,

a romantic partner, but also with less close peers. In social functioning scales such as these, relatively less attention is paid to more qualitative aspects of social interactions. However, as recognized by most researchers of social relations, both the quality (or experience) and quantity (or behaviors) of social encounters are relevant elements of adaptive social processes (Antonucci et al., 2019). As such, it has been argued that the concept of social functioning would benefit from including more qualitative elements as well (Priebe, 2007). To gain a greater understanding of the transdiagnostic role of social processes in adolescence, in this thesis, we will therefore focus on both quantitative social functioning outcomes (e.g., amount of time spent with others), and more qualitative aspects (e.g., how someone feels when with others).

In this endeavor, it is particularly relevant to look at this relationship during a time when most psychopathology has not yet developed into a diagnosable clinical disorder. When comparing adults with versus without a psychiatric disorder, the former group will likely report lower levels of social functioning. However, as those with a disorder often have highly differently structured lives (e.g., they are more likely to be unemployed), it is difficult to assess whether any social dysfunction in patient groups is due to internal vs. contextual factors (Kasanova et al., 2018). In this thesis, we focus on two general population samples of largely school-going adolescents, who will mostly have similarly structured lives. As such, the role of potential confounders is smaller than in adult studies, and we are better able to make accurate assessments of the relationship between subclinical psychopathology and social processes.

An additional reason for looking at adolescents, is that adolescence is not only a sensitive period of psychopathological development, but also of strong social changes (Blakemore & Mills, 2014). Between child- and adulthood, adolescents develop a new type of relationship with their parents, where eventually, an increasing independence is developed. Although early emphases on adolescence as a tumultuous period of 'Sturm und Drang' (G. S. Hall, 1904) have since been tempered (Arnett, 1999), it does still represent the sometimes challenging period where one's autonomy is developed. Tensions between parent and child rise in early adolescence, peak in middle adolescence, while the parent-child relationship improve again during later adolescence and young adulthood (Meeus, 2016, 2018). Concurrently, relationships with friends become increasingly important throughout adolescence (de Goede et al., 2009; Grusec & Davidov, 2021). Throughout adolescence, however, there is also a high continuity where parents remains incredibly important figures for emotional and social support – and as such, for adolescents' development (Collins & Laursen, 2013)

These key challenges for adolescents – to both maintain and develop new types of relationships with both peers and family members, and to become independent members of society – are all inherently social in nature (Smetana

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et al., 2015). When these challenges are inadequately met, ample longitudinal evidence suggests that lasting distress – in the form of psychopathology may develop (Meeus, 2016, 2018). Therefore, to understand which transdiagnostic factors may underlie the development of early psychopathology, it is highly worthwhile to focus specifically on social factors, parenting, and on the general population of adolescents.

1.3.2 Online social interactions

In discussing relevant social factors for adolescent well-being, one cannot neglect how incredibly different adolescents' social worlds are from, say, just twenty years ago. In 2020, 5.19 billion people were estimated to use mobile phones, while half of the global population, 3.8 billion people, was estimated to use social media (Kemp, 2020). Moreover, about half of the 3.7 hours that people worldwide spend online each day is spent using social and communication apps (Kemp, 2020) – indicating the incredible social component of the digital world we currently live in. Using digital technology to communicate with others online is a particularly popular pastime for adolescents. For example, 93% of all Flemish adolescents (the main target population in the current PhD project) has a smartphone, and over half of them uses their smartphone more than 4 hours a day on non-school days (Vanhaelewyn et al., 2020).

Much of the work done on the effects of this digitalization has focused on its potential negative effects, where some have even claimed how smartphones "have destroyed a generation" (Twenge, 2017), and have stated a need to "pull teenagers out of the smartphone trap" (Haidt & Twenge, 2021). The rise of digital technology and increasing amounts of adolescent screen time have been related to adolescents being less social in-person (Twenge et al., 2019), the emergence of new disorders such as gaming addiction (D. Griffiths et al., 2012), social media addiction (Hou et al., 2019), or even YouTube addiction (de Bérail et al., 2019), but also to general increases in depression and suicide (Twenge et al., 2018). More recently, however, large-scale empirical studies have disputed these claims, and found, for example, how the general relationship between screen time or social media use and adolescent well-being is so small that it is unlikely to be practically significant (Odgers & Jensen, 2020a; Orben & Przybylski, 2019a).

In other words: The field is strongly divided. In order to gain reliable knowledge on the relationship between digital technology use and adolescent well-being, more targeted investigations focusing on specific research questions are required. It cannot be dismissed that going online to communicate with others is qualitatively different from interacting face-to-face (Lieberman & Schroeder, 2020) – but what are the effects of those differences? To generate more useful knowledge on the impact of online social interactions for adolescent well-being,

we need more targeted, specific investigations. Therefore, in this PhD project, we will take a closer look, and focus on the direct affective benefits or detriments that adolescents experience as they engage in online vs. face-to-face social interactions.

1.3.3 The pertinence of parenting

Although during adolescence, stronger relationships are developed with peers through both face-to-face and online interaction, the most-researched and most well-established social agent during adolescence continues to be the parent (Smetana & Rote, 2019). While the notion that parents carry the sole responsibility for children's development is not commonplace anymore (e.g., cf. the theory of the 'refrigerator mother' causing autism; van Rosmalen et al., 2020), modern developmental work continues to agree on the fact that the parent-child relationship is of critical importance for both children's and adolescent's socialization and mental health (Davies & Sturge-Apple, 2014; Grusec & Davidov, 2021; Smetana & Rote, 2019).

In their assessment of what aspects of parenting are meaningfully related to child and adolescent development, parenting scholars have historically distinguished between parenting styles, parenting behaviors, and parenting dimensions (Steinberg & Darling, 1993). Parenting styles have been defined as the environment and atmosphere in which children are brought up – and they form the context in which specific parental behaviors (e.g., reward or punishment) are expressed (Steinberg & Darling, 1993). Most late-20th-century parenting theorists have characterized the 'ideal' parenting style as a variation on Diana Baumrind's definition of authoritative parenting, which was later defined as a parenting style that is high in the dimensions of both demandingness and responsiveness (Baumrind, 1966, 1971, 1991; Maccoby & Martin, 1983). In this sense, parents who both set firm rules and are responsive to their child's needs are expected to produce the most socially well-adapted children.

Most parenting research, however, has focused on the effects of more specific parenting dimensions rather than composite parenting styles (Smetana, 2017). In the prediction of psychopathology, a focus on dimensions is useful, as it allows for the investigation of the most relevant predictors for the development of mental illness. Although defined in different ways, the parenting dimension of generally responsive (or warm, caring, responsive, accepting) parenting, for example, has been related to well-adjusted and socially competent children (Davidov & Grusec, 2006; Rispoli et al., 2013). Low levels of parental care, in turn, are associated with a myriad of psychiatric disorders, such as depression, anxiety disorders, and substance use disorders (Enns et al., 2002; Eun et al., 2017). Note that these associations are also in line with attachment theory (Bowlby, 1969),

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which also describes how responsive parenting leads to a high-quality parent-child attachment relationship, which in turn is a necessary requirement for adaptive adult functioning.

For parenting related to the parenting dimension of control, the adaptive nature depends on the type of control that is exerted. Behavioral control refers to the setting of rules and providing of clear structure in children's lives – and this is considered generally adaptive (Barber, 1996). However, parental control can also be maladaptive. Psychological control refers to a parenting style that undermines a child's psychological autonomy, for example when parents invalidate the child's perspective, or when they engage in guilt induction (Barber, 1996; Barber & Harmon, 2004; Schaefer, 1965). The difference between behavioral and psychological control, then, is that behavioral control aims to control the child's behavior, while, with psychological control, an attempt is made to control the child's psychological experience (Barber & Harmon, 2004; Soenens & Vansteenkiste, 2010). Maladaptive parental control has also been investigated in the definition of overprotective parenting – also referred to as 'helicopter parenting' – in which parents are overly controlling (Weitkamp & Seiffge-Krenke, 2019). Both parental psychological control and overprotection have been associated with the development of different types of psychopathology – from child- to adulthood (Barber et al., 2005; Enns et al., 2002; Eun et al., 2017; Soenens et al., 2005; Soenens & Vansteenkiste, 2010). Finally, autonomy supportive parenting, in which children and adolescents are provided with the freedom to make their own decisions and supported and encouraged in doing so (Soenens et al., 2007), has been associated with adaptive outcomes, such as lower psychopathology levels (Ryan et al., 2015), and higher levels of social competence (Soenens & Vansteenkiste, 2005).

The long-lasting relationships between of care- and control-related parenting styles and well-being indicate their strong relevance for understanding child, adolescent, and adult development. However, the immediate mechanisms through which specific parenting styles impact psychosocial development are less clear. One approach might be to understand these relationships through altered attachment relationships. From the perspective of attachment theorists, specific parenting styles largely determine the nature and quality of the parent-child attachment bond (Ainsworth et al., 1978; Karavasilis et al., 2003). In turn, this initial attachment bond co-shapes the relationships that a child, adolescent, and adult will form with their siblings, peers, and partners – which, again, relate to that person's well-being. This purported mechanism, however, is still relatively indirect. In research in adolescents and adults, the attachment bond is usually assessed using self-report questionnaires that aim to capture the latent internal working model that is thought to drive social behavior. What is less clear, is how these parenting styles relate to social behavior more directly. Therefore, in this

thesis, we focus on day-to-day social interactions.

1.4 Filling the gap of daily life

1.4.1 The need for increased ecological validity

Focusing on social factors requires that we measure these factors in a reliable and valid manner. In psychology and psychiatry research, social factors are usually measured through a self-report questionnaire, an interview, or an experiment in the laboratory. The validity of such assessments hinges on one crucial assumption: That its results say something about the social interactions in people's day-to-day lives. If, for example, a questionnaire indicates that someone has a high level of social distress, but this person does not have any social difficulties in their daily life, this questionnaire would not be valid. After all, it is in day-to-day life that social distress is experienced. The extent to which any measure relates to day-to-day life is also referred to as *ecological validity*.

The concept of ecological validity can be separated further into 'representativeness', or the similarity in content and experience of an assessment to its underlying construct in the real world, and 'generalizability', or the accuracy of any measure in predicting its real-world counterpart (Burgess et al., 2006; Franzen & Wilhelm, 1996). Most measures of social processes are not very representative. For example, when someone is sitting alone behind a computer, filling out a questionnaire on general peer support, there is little similarity between the experience of the assessment and the experience of the underlying construct. Still, if the results of this peer support questionnaire are actually predictive of how much support is experienced in day-to-day life, we would still be happy with the measure – as it is still generalizable.

However, much evidence suggests that most assessments of social factors are neither representative nor generalizable. As discussed in Chapter 3 of this PhD (on the ecological validity of social cognition measures in psychosis), real-world social interactions are dynamic, context-dependent, and involve all senses (Zaki & Ochsner, 2009). Consequently, aspects of social interactions are difficult to capture. This difficulty has, for example, been demonstrated by cognitive psychological work that shows how the recall of social interactions is strongly influenced by current mood (Bower & Forgas, 2001; Forgas et al., 1984). Recent studies on the recall of a contemporary type of social behavior – social media use – also reveal how there is little convergence between social media use as assessed retrospectively vs. in daily life, using passive sensors (Ernala et al., 2020; Sewall et al., 2020). Moreover, evidence suggests that recall biases when remembering social information are stronger for those with greater levels of, e.g., depression (Bone et al., 2021) or social anxiety (Glazier & Alden, 2017) – which

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implies that research into the relationships between psychopathology and social factors may be strongly affected by such biases. Therefore, to better understand the role of social factors in adolescent development, research is required that uses ecologically valid assessments of those social factors.

1.4.2 The experience sampling method

One method that can be used to capture social information with a sufficient level of ecological validity is that of daily diaries. By asking people to report on their social interactions at the end of each day, daily diaries allow for gathering daily fluctuations in social behaviors and experiences. However, given the vast amount of social behavior that people usually engage in on any given day, end-of-day reports may still be prone to recall bias.

To capture daily fluctuations in social interactions with greater precision, assessment tools that measure at least multiple times per day are more appropriate. The experience sampling method (Csikszentmihalyi & Larson, 1987; Myin-Germeys et al., 2018) is such a tool. In an ESM study, participants go about their day as they would normally do, can be notified at (semi-)random moments during their day, and consequently fill out a brief questionnaire about their current situation. They may report on their thoughts, behaviors, feelings, and current context, but also on any social interaction that they may have at the time of the random prompt. In this way, both quantitative (e.g., how much does someone generally interact with other people?) and qualitative (e.g., how does someone generally feel about the company they are in?) aspects of day-to-day social interactions can be captured. The main advantages of ESM are that it severely minimizes recall bias, that assessments are highly ecologically valid, and that fluctuations over time and in different contexts can be assessed. As participants are prompted at random moments throughout their day, the data obtained through ESM reflects a representative, ecologically valid image of participants' daily lives at that point in time. As such, in this PhD, we will use ESM to assess daily-life social interactions in adolescents.

1.4.3 A cross-level interaction

In addition, ESM provides us with a great tool for exploring and testing the theoretical notion that context matters. This notion is not new: For example, in both Bronfenbrenner's bioecological model (Bronfenbrenner, 1979; Bronfenbrenner et al., 2007) and Lerner's developmental contextual approach (Lerner, 1991), it is asserted how an adequate understanding of people's development requires a focus on their different day-to-day environments. The dynamic interaction between person and (social) environment is key for understanding how

adolescents grow up – and also, for understanding when development goes awry and psychopathology may develop. This idea of an interaction between person and environment is also present in dynamic systems models (Kunnen et al., 2019; Smith & Thelen, 2003; van Geert & Lichtwarck-Aschoff, 2005) which describe how processes at different levels and at different time scales interact in shaping adolescent development.

Despite these different theoretical frameworks having emphasized the importance of considering different (naturalistic) contexts and different time scales, not much research has actually assessed developmental and social processes in daily life. This is where ESM comes in. Using ESM, we are able to measure daily-life social processes, and this allows us to better explore the interaction between adolescents and their day-to-day social environments. Previous research has also used ESM to assess adolescents' day-to-day social interaction (see the fundamental work done by Csikszentmihalyi & Larson, 1986), but relatively little work has used this method to also investigate the relationships between more general processes of parenting and psychopathology to qualities of these daily interactions as they happen in the moment. By relating person-level characteristics to micro-level processes, we can gain insight into some of the most relevant cross-level relationships driving the development of early psychopathology.

1.5 Main model of this dissertation

As discussed, we know that certain types of parenting predict psychopathology – but the processes at the everyday level that underlie this association are largely unexplored. Daily-life social processes are a prime target for better understanding the link between parenting and psychopathology in adolescence, as psychopathology is inherently social, parenting is a quintessentially social predictor of psychopathology, and as adolescence is a crucial period of social change. By exploring the daily-life social correlates of both parenting and of general psychopathology, we gain insight into the potential common pathways underlying (mal)adaptive adolescent development.

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Figure 1: Main model of this PhD project, linking social behaviors/experiences in daily life to both antecedents of psychopathology, and to psychopathology itself.

This brings us to the overarching model of this PhD, displayed in Figure 1. Taken together, I will focus on social interactions in the daily lives of adolescents, how they relate to different types of parenting, and how they are associated with general psychopathology. First, I will look at these associations separately, before bringing parenting, psychopathology, and social interactions with different types of interaction partners together. Given the relevance of the digital world for socializing adolescents, I will also explore how the direct experience of online social interactions differs from face-to-face social interactions.

During the writing of this doctoral thesis, the relevance and salience of the topics discussed in it unexpectedly increased. Although the COVID-19 pandemic has not posed a great direct threat to the physical health of adolescents, the associated distancing measures have had an enormous impact on their social lives. Given the essential nature of social interaction for adolescent development, it was expected that the social deprivation that has accompanied different stages of the COVID-19 pandemic might strongly impact adolescent well-being (Orben et al., 2020). However, while much research has emerged during the pandemic on its potential psychological effects, only a limited number of studies have had access to psychopathology data both before and during the pandemic – let alone in youth (Sun et al., 2021). Moreover, while widely discussed, the exact

impact on adolescents' social lives was largely unknown.

Therefore, within this PhD project, I decided to expand our aims, and to also focus on pre- to early-pandemic changes in psychopathology, and risk factors for the development of (increased) psychopathology levels. In addition, I look at pre- to early-pandemic changes in the quantity and quality of daily-life social interactions, and whether certain aspects of those social interactions have become stronger predictors of well-being.

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Chapter 2:

Objectives, Scope, Data and Open Science Practices

2.1 Objectives

In this doctoral thesis, I will focus on the following overarching, general aim:

Objective 1: To assess the relationships between parenting characteristics, psychopathology, and daily-life social processes in adolescents

This objective is divided in three consecutive steps. First, in **Chapter 4**, we assess the relationship between parental bonding and the quantity and quality of daily-life social interactions of adolescents. In **Chapter 5**, we investigate the relationship between the quantity and quality of everyday social interactions, and general psychopathology levels. In **Chapter 6**, we extend Chapters 4 and 5, by investigating specific relationships between maternal/paternal parenting styles and the experience of daily-life social interactions with mothers, fathers, and non-family members, and by associating these parenting styles and social experiences with general psychopathology.

In the previous chapters, we focus solely on the experience of face-to-face interactions. However, as the social behaviors of the contemporary adolescent also largely happen in the digital world – and as we don't know much about the differential experience of these types of interactions – we formulate a second objective:

Objective 2: To assess differential momentary affective well-being when adolescents engage in face-to-face vs. online social interactions

In **Chapter 7**, we use ESM to identify how adolescents feel when they are engaging in an online interaction vs. engaging in a face-to-face interaction vs. being alone. Assessing their feelings and experiences *at the moment of interaction* is a relatively unique approach that provides novel knowledge about the direct potential benefits of online interaction. Moreover, we assess whether some adolescents (i.e., those with fewer/more social resources) might benefit more from online social interaction than others.

The main topics of this PhD – youth social behavior and psychopathology – unexpectedly became increasingly relevant near the end of this PhD project, when the global COVID-19 pandemic hit. The prolonged measures to combat the pandemic involved a severe reduction in the possibilities for young people to engage in social activities, and this has been widely claimed to have had a great impact on their mental health as well. To test this claim, this PhD project contains a third objective:

Objective 3: To assess the impact of the COVID pandemic on adolescents' daily social interactions and psychopathology levels

In **Chapter 8**, we assess how adolescents' mental health, and the quantity and quality of their face-to-face and online interactions with different types of interaction partners has changed from before the pandemic to the early stages

of the pandemic. Moreover, we investigate the role of multiple pre-pandemic and early-pandemic risk and resilience factors, and we assess how the relationship between different aspects of daily social interactions and psychopathology has changed during this time of imposed social deprivation.

2.2 Scope of this PhD

In this PhD project, we draw on data collected from representative samples of Flemish and Dutch adolescents and young adults from the general population. We do not use any clinical diagnosis of mental disorders, and do not specifically target multiple psychopathologies. The aim of this PhD project was to provide a picture of the relationship between social interactions and psychopathology *symptoms* at an early, largely preclinical stage, and this necessarily means that we are not able to speak to the development of distinct types of clinically relevant psychiatric distress. In addition, with the exception of the final COVID chapter, we have mainly looked at cross-sectional data from single waves of data collection. A major underlying presumption of this PhD project is that alterations in daily-life social interactions partially mediate the relationship between parenting and psychopathology. However, as testing this mechanism requires multiple waves of data, this implied mediation effect is not tested here, only explored.

At the same time, these limitations provide excellent opportunities for further building on the findings reported in this dissertation. In this PhD, we put everyday social interactions on the map; in the future, we aim to draw on these explorations to develop the much-needed robust knowledge on the longitudinal prediction of mental distress by alterations in daily social interactions.

2.3 Data Used

This PhD project draws on data from two major ESM datasets: The TwinssCan dataset (Pries et al., 2019) and the SIGMA dataset (Kirtley et al., 2021). For the TwinssCan project, participants were sampled from the East Flanders Prospective Twin Survey, a population-based registry of the birth of twins in the East Flanders region of Belgium (Derom et al., 2019). I was not personally involved in the TwinssCan project, as these data were all collected in 2010, before the start of my PhD project. The TwinssCan project contains a large battery of different questionnaires and experimental tasks, but we have used data from retrospective questionnaires and from the six-day experience-sampling period that participants had engaged in. We were able to use data from version 2.2 of the TwinssCan data set, which comprises a total sample of $N = 778$ adolescent twins and their siblings between the ages of 15 and 34. Because, in this PhD, we were largely interested in adolescents and young adults, we limited the sample

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to the $n = 663$ participants up to age 21. TwinssCan data were used in Chapters 4 and 5.

The SIGMA dataset was collected by my colleagues at the Center for Contextual Psychiatry and myself, starting in 2018. The SIGMA study has an accelerated longitudinal design, in which different age cohorts are included from the first wave onwards (Galbraith et al., 2017) – thus already allowing for assessing age differences after only one wave of data collection. All adolescent participants were tested in their classrooms, where they completed a questionnaire battery, and where some were asked to participate in a social-behavioral experiment. Afterwards, participants engaged in a six-day experience-sampling period, similar to the TwinssCan study. For the first wave, $N = 1913$ participants between ages 12 and 19 were recruited from secondary schools throughout the full Flanders region of Belgium, thereby comprising the largest adolescent experience-sampling dataset that we are aware of. SIGMA data were used in Chapters 5, 6, 7, and 8. Almost all chapters draw on data from Wave 1 only, but Chapter 8 also uses data collected from $n = 173$ SIGMA participants during an additional wave of data collection in the early stages of the COVID-19 pandemic.

2.4 Open Science Practices

Throughout the course of this PhD project, our team at the CCP has been at the forefront of transparency, reproducibility, and replicability in science – largely guided by my co-promotor Dr Olivia Kirtley. All but one of the empirical papers presented in this thesis have been registered on the Open Science Framework (OSF) – all after or during data collection, but before data were analyzed (we were not fully on the “Open Science train” at the start of this PhD, which is why the first study in Chapter 3 was not registered). Moreover, during this PhD project, we have developed a template and tutorial specifically for the (pre)registration of ESM studies (Kirtley, Lafit, et al., 2020). All R code and output used for our analyses, and the materials and questionnaires used in the SIGMA studies, is made available online on the OSF-pages of the respective projects. All ESM items are also available in the ESM item repository (www.esmitemrepository.com), co-developed by my CCP colleagues (Kirtley, Hiekkaranta, et al., 2020). Finally, all chapters presented in this dissertation have been made available as preprints online, all on the PsyArXiv website. These preprints, but also the code and materials, can be retrieved via my public OSF-page: www.osf.io/dt9fe. Direct links to the pre-analysis registrations can be found within each individual chapter.

Chapter 3:

Improving Ecological Validity in Research on Social Cognition

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Abstract

Within psychosis, impairments in social cognition have been hypothesized to be a driving force behind daily-life social impairments. However, traditional measures of social cognition have low ecological validity, as evidenced by a weak correlation between social cognition and social functioning, and the limited usefulness of treatments aimed at improving social cognition. In order to obtain a more comprehensive view of social impairments, assessments are needed that take into account the multifaceted, dynamic, contextualized, and interactive nature of social interactions. In this chapter, criteria will be discussed that are necessary for achieving high ecological validity. In addition, the use of Virtual Reality (VR) and Experience Sampling Method (ESM) will be discussed in the context of the contribution so far and future potential of these techniques in order to better understand and intervene on the mechanisms contributing to social impairments in psychosis.

Social cognition has been conceptualized as a set of psychological processes involved in social behavior and social interaction. It allows an individual to process social information within an interaction by identifying, interpreting, and reacting to others' thoughts and emotions. Traditional research on social cognition has primarily used cognitive tasks in laboratory settings to investigate distinct aspects of social cognition, mainly emotion perception, ToM, and attributional style (Penn et al., 2008). Research in patients with psychosis has shown a clear deficit in social cognition across its multiple domains (Savla et al., 2013). It has also been hypothesized that the traditional concept of social cognition plays a role in the etiology of both positive and negative psychotic symptoms due to the assumed impact social cognition has on how people interpret and make sense of their social world. For example, experiences of paranoia have been related to deficits in emotion recognition and attribution biases, i.e., misattributing neutral stimuli to be negative (Lahera et al., 2015; Premkumar et al., 2008). Studies on negative symptoms in psychosis have mainly found links to emotion perception and processing, which is linked to social behavior. For instance, one study found that 39 percent of variance in asocial behavior (such as social isolation and social anhedonia) can be explained by social cognition variables (Lincoln et al., 2011).

The relevance of the social cognition concept lies in the tacit assumption that adequate social cognition is required for successful social functioning. For patients with psychosis, the concept is meaningful insofar as it explains social impairments in their day-to-day lives. In other words, social cognition necessitates a degree of ecological validity. This can be investigated by assessing its link with social functioning. The capacity to adapt one's behavior to changing social contingencies and cues, i.e., social cognition, is in fact thought to be essential for optimal social functioning in general and by extension, an important indicator of mental health (Green et al., 2008, 2015). Unequivocally, psychosis is associated with social impairments. When assessed in terms of family situation and employment, prevalent deficits are observed in participants with psychotic disorders compared to controls (Bebbington et al., 2005). Furthermore, higher rates of functional disability were reported in patients with psychosis than in controls (Green et al., 2008, 2015), such as diminished social connections, lower employment rates, and less independent living situations (Green et al., 2018). These studies indicate that social impairments are crucial targets for prevention and intervention. However, it is not evident that social cognition deficits actually drive these impairments. A complicating factor in the assessment of the ecological validity of social cognition lies in the ambiguity of the definition of social functioning. Despite being a much-researched construct, there is a lack of consensus on the definition of social functioning. Definitions are typically used interchangeably across research domains, employing different perspectives to describe social functioning (Brissos et al., 2011; Burns & Patrick,

2007; Käkälä et al., 2014; Priebe, 2007). This ranges from objective assessment of the frequency of engagement in social interaction and fulfilment of social roles (Global Assessment of Functioning Scale, SFS, (Birchwood et al., 1990); Global Assessment Scale, GAS, (Endicott et al., 1976)), to measuring subjective appraisals (feelings and thoughts) or an evaluation of social situations, such as social stress. Many authors argue that the concept of social functioning should be approached from both an objective and a subjective perspective (Brissos et al., 2011; Burns & Patrick, 2007; Schneider et al., 2017). In practice, however, social functioning has predominantly been described with objective or primarily observer-based indices instead of self-report. In this chapter, we will offer evidence that a subjective, individual perspective on social functioning is ideally suited to advance our understanding of social impairments and the role of social cognition.

For optimal assessment of social impairments and understanding of the factors underlying social impairments, the link between social cognition and real-life social functioning should be firmly established. Currently however, the evidence is equivocal and there is a dearth of evidence specifically investigating this link. This, therefore, raises the fundamental question of whether social cognition is a prerequisite for social functioning. In light of this question, we will now go on to discuss the link between social cognition and traditional social functioning, before we discuss a broader framework of ecological validity of social cognition. We will then focus on two approaches with high ecological validity to investigate social cognition and social functioning in a wider sense - Virtual Reality and the Experience Sampling Method - and finally discuss considerations and implications for future research and clinical practice.

1. Social cognition: a prerequisite for social functioning?

Individual studies have reported on correlations between social functioning and specific domains of social cognition, such as ToM (Sprong et al., 2007), emotion recognition (Henry et al., 2015; Hooker & Park, 2002), emotion perception (Irani et al., 2012), and attribution bias (Lahera et al., 2015). Overall, the link between social cognition and social functioning has mainly been based on correlational studies, which precludes conclusions about directionality (Couture et al., 2006; Fett et al., 2011). Moreover, a meta-analysis by Fett and colleagues (2011) shows that only 16 percent of variance in social functioning can be explained by social cognition. This percentage is surprisingly small, given the widely-held assumption that social cognition is a strong determinant of real-life social functioning (Green et al., 2015). A recent study also did not observe any significant association between social cognition and self-reported social functioning (Simons et al.,

2016). One possible explanation for these inconsistencies is that the relationship between social cognition and social functioning is mainly accounted for by other factors. For instance, one study showed that the association between measures of social cognition and social functioning disappeared when neurocognition was controlled for (Woolverton et al., 2018). Based on these findings it is argued that, although a link between a traditionally-measured social functioning and social cognition was established, the lack of subjective, ecologically-valid perspective prevents it from being clinically and mechanistically relevant.

Based on the assumption that deficits in social cognition strongly contribute to social functioning impairments, and play a role in the emergence of positive and negative symptoms, several interventions targeting social cognition have been developed. These aim to improve social functioning and reduce symptoms in patients with psychosis. In particular, several programs of cognitive remediation therapy focus on social cognition (e.g. CIRCuiTS; (Reeder et al., 2016; Wykes et al., 2018), and include daily functioning as one of the main outcome variables (Wykes et al., 2011). Although an initial meta-analysis showed a medium effect size in different cognitive domains (McGurk et al., 2007), a more methodologically rigorous meta-analysis showed a small-to-medium effect size of cognitive remediation therapy on functioning outcomes (Wykes et al., 2011). The authors concluded that the improved or newly acquired cognitive skills should be complemented with strategies for their implementation in daily life. That is, the authors pointed out that personalization for specific participants and their environments was critical for the effectiveness of the treatment (Fett et al., 2011). These and other social cognitive treatments have, thus far, provided limited evidence for a direct relationship of social cognition deficits with social functioning in daily life (Fiszdon & Reddy, 2012).

In sum, the basic assumption of theories of social cognition is that these deficits result in alterations in social behavior, thereby having a negative impact on social functioning. The main empirical support for this association, however, comes from laboratory studies that in fact show weak correlations between social cognition and social functioning. Additionally, treatments specifically aimed at improving social cognition do not show large improvements in daily social functioning. Therefore, it is uncertain whether social cognition is, in fact, a prerequisite for social functioning. Other authors have gone beyond the traditional idea that social cognition drives impairments in social functioning. They focused on alternative factors driving social functioning that should be investigated within this link as well, such as effort allocation, prediction error processing, expected value-driven learning and action selection (Barch et al., 2016). An alternative way of conceptualizing the link between social cognition and social functioning, however, is the Social Interaction First (SIF) hypothesis, in which social cognition has been posited as the result of more basic social

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interactive abilities (Schneider et al., 2020). It is in contrast to the Social Cognition First (SCF) hypothesis, which assumes that social cognition is a prerequisite for social functioning (Carruthers, 2009; Schönherr, 2017), and therefore questions whether social cognition explains and predicts social difficulties in patients with psychosis. Particularly in clinical research, an alternative line of study would be to focus on mechanisms underlying social interactive abilities in daily life. The next section will further discuss the concept of ecological validity with regard to social cognition.

2. Ecological validity

Cognitive psychology has seen a surge of attention devoted to increasing ecological validity of cognitive concepts in general (Burgess et al., 2006), and social cognition in particular (Zaki & Ochsner, 2009). Conceptually, Burgess and colleagues (2006) advocated that the focus of research should shift from a 'construct-driven' to a 'function-led' approach in order to improve ecological validity. From this perspective, the cognitive construct (e.g., emotion perception) is not the central focus of attention, but rather its function in observable behavior (e.g., being empathic to someone). Related to this view are the concepts of representativeness and generalizability, which have been proposed as the requirements for experimental tasks to be considered ecologically valid (analogous to the terms verisimilitude and veridicality; (Franzen & Wilhelm, 1996). Representativeness refers to the similarity in content and experience of an experimental task with the real world. For example, a paradigm in which participants have to perform a complex shopping task is more representative of potential limitations in the real world than, for instance, a Stroop task (MacLeod, 1991; Stroop, 1935). Generalizability, on the other hand, refers to how well an experimental task is actually predictive of its associated behavior or functioning in real-life. A generalizable task is not necessarily 'real-world'-like. For example, the result of a pen-and-paper driving test could be more predictive of actual driving capacity than performance on a highly realistic racing video game. In this example, the game might be more representative, but the test would be more generalizable.

As highlighted in the previous section of the chapter, several studies observed no significant association between tasks of social cognition and actual daily-life social functioning (Simons et al., 2016; Woolverton et al., 2017), which provides arguments against the generalizability of such tasks. In addition, social cognition and its related concepts have mainly been investigated and developed in controlled laboratory settings. Since traditional social cognition tasks (involving e.g., emotion recognition of photographed faces, or identifying beliefs of characters in written scenarios) are highly experimental in nature, they also do

not meet the representativeness requirement. The link between social cognition concepts and real-world social behavior is therefore often indirect and artificial.

Compared to real-life social situations, experimental tasks designed to assess aspects of social cognition tend to lack at least three real-world attributes of interacting partners: 1) multimodality (with visual, semantic, and prosodic elements); 2) dynamic change; and 3) a context of previous experiences with that partner (Zaki & Ochsner, 2009). In experimental tasks of social cognition, the social situation is thus usually discrete, static, and isolated. Additionally, the interactive nature of real-life social processes may involve qualities that extend beyond the sum of individual social capacities.

Within the field of social cognition, two main approaches can be identified, namely a 'third-person' and a 'first-person' approach (Keysers & Gazzola, 2007; Pfeiffer et al., 2013). In the third-person approach, one is a somewhat detached observer of the other, inferring at a cognitive level about another person's mind (as in ToM). In the first-person approach, however, emotions or mental states of the other are more directly experienced, as if they were one's own (as in emotion recognition). Neuroimaging studies based on either the 'third-person' or the 'first-person' approach have found mostly non-overlapping neural networks, even though they both aim to target and explain the same concept (i.e., social cognition and social behavior). This implies that these traditional views of social cognition have insufficient explanatory value, and that an alternative paradigm is necessary (Keysers & Gazzola, 2007; Pfeiffer et al., 2013; Schilbach et al., 2013; Zaki & Ochsner, 2009). As argued by, for instance, Schilbach and colleagues (2013), social cognition research would benefit from a 'second-person' approach, where the interactive element of social behavior is taken into account. Their perspective builds upon the idea of 'embodied cognition', where an individual is not just a spectator of their environment and the people in it, but is in a state of constant interaction. Social cognition then arises when someone is both emotionally engaged and in interaction with another person, as opposed to being detached and merely observant.

In sum, by not meeting the requirements of representativeness and generalizability, traditional social cognition research has limited ecological validity. In an attempt to address this issue, some investigations into social cognition have employed more naturalistic assessment methods. For example, participants were asked to infer the thoughts and feelings of an interactive partner during a secretly videotaped interaction from moments before (Ickes, 1997; Ickes et al., 1990). The accuracy of these assessments was obtained by independently asking the interactive partner to provide an account of their thoughts and feelings. This method is, however, still a somewhat indirect way of tapping into everyday social interactions. For one, participants have to recall their (meta-)thoughts, feelings and inferences at a later point, which makes

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them prone to recall bias. Additionally, the social situations that can be assessed using these sorts of paradigms still take place in laboratory settings, leaving the question of generalizability to real-world situations unanswered.

Alternative methods for assessing social cognition and social functioning that meet the conditions of representativeness and generalizability are available. In the next sections, we will review existing research using virtual reality (VR) and the experience sampling method (ESM) in patients with psychosis. In VR, virtual environments are becoming increasingly similar to real life, invoking experiences that are more representative of real-life situations. In ESM, on the other hand, measurements are drawn directly from daily life, thereby allowing for the assessment of the generalizability of findings obtained in experimental settings. Accordingly, we will discuss the contribution of these methods to a more naturalistic understanding of social cognition.

3. Virtual reality

In the advent of the technological revolution of the last two decades, VR techniques have become increasingly widespread, available, and sophisticated (Valmaggia, 2017). VR is typically defined as the presentation of a computer-generated three-dimensional environment, in which the user receives visual (and sometimes auditory or haptic) input that is directly influenced by that user's movements¹ (Eichenberg & Wolters, 2012). Different types of VR technology are currently available, with the most well-known application being a head-mounted display that links head movements in real time to the virtual environment that it presents. The aim of VR is to present a virtual world that is immersive and is experienced as being authentic.

As such, VR has also been adapted for use in the field of mental health, with a specific focus on the assessment of social processes (Brunet-Gouet et al., 2016; Freeman et al., 2017; Parsons, 2015). As discussed, social cognition and related social processes are difficult to assess with traditional experimental tasks, since such tasks usually do not take into account the multimodal, contextual and dynamic aspects of social interaction. Furthermore, through the standardized presentation of a virtual environment and the possibility to control and manipulate every aspect of that environment, it becomes possible to differentiate between objective context characteristics and personal interpretations of that context. Following the 'function-led' approach to ecological validity (Burgess et al., 2006), VR most directly meets the criterion of representativeness, defined as

¹ Other definitions of VR include simpler virtual environments (Froese, Iizuka, & Ikegami, 2014), but in this chapter only immersive VR applications are discussed.

the extent to which a task relates to a situation outside of the lab in form and environment.

VR techniques seem to be acceptable and safe to use for people with psychotic symptoms (for further discussion of this, see (Rus-Calafell et al., 2017). Furthermore, the feasibility of VR technology to assess aspects of social cognition in individuals with psychotic symptoms has also been tested in a number of studies. In an initial feasibility study (Ku et al., 2003), 11 patients with schizophrenia engaged in a virtual reality task by controlling a joystick, which enabled them to move toward or away from another virtual avatar. The VR was not immersive, as the virtual environment was projected on a screen. The virtual avatar had breathing motions and blinked, but showed no facial emotions, did not make any gestures, and had a very basic appearance. Outcome variables assessed were the virtual interpersonal distance, and verbal response time in a simple scripted conversation. The authors found that interpersonal distance was negatively related to the severity of negative symptoms. Head-mounted displays were used to present the same virtual environment in a follow-up study (Park et al., 2009). Interpersonal distance to the avatar was found to be significantly larger for 30 patients with schizophrenia than for 30 controls. In another study from the same research group (Kim et al., 2007), several aspects of social perception were investigated, although a clear description of the VR procedure is lacking. Overall, significant differences between schizophrenia patients and healthy controls were observed on a number of social perception variables, involving emotion recognition and interpretation of environmental cues. Two other studies investigated the feasibility of VR to assess emotion recognition through a task where participants with schizophrenia or healthy controls had to indicate the basic emotions of virtual faces (Dyck et al., 2010; Gutiérrez-Maldonado et al., 2012). These authors found similar emotion recognition impairments as those reported in studies using photographs of real faces.

Although the abovementioned studies employed rather unsophisticated VR techniques, virtual environments have quickly become more immersive and convincing. However, realistic and immersive VR does not necessarily imply high ecological validity. As noted by (Parsons, 2015), many early VR studies incorporated traditional neurocognitive tests (e.g., a Stroop task) into a virtual environment (e.g., Henry et al., 2012). Similarly, the emotion recognition and social perception VR studies focused on specific components of social cognition (Dyck et al., 2010; Gutiérrez-Maldonado et al., 2012; Kim et al., 2007; Ku et al., 2003; Park et al., 2009). Since such studies target specific cognitive modalities, they do not enrich our understanding of how such modalities might be involved in the complexities and dynamics of actual behavior in daily life.

A function-led approach would be better suited to gain more insight into the underpinnings of social processes that have actual relevance for day-to-day

interactions. Through focusing on behaviors and the natural context in which they occur, more information can be gathered about the entire spectrum of factors involved in function versus dysfunction. An example is a study in which 43 participants with schizophrenia engaged in both a VR and real-life supermarket shopping task (Greenwood et al., 2016). The participants also completed a comprehensive test battery of traditional neurocognitive tests aimed at capturing the wide range of cognitive performance involved in daily functioning. The authors found that after taking into account these cognitive measures, the virtual shopping task still significantly predicted real-life performance. This implies that the abilities needed to perform functions in everyday life exceed the joint sum of traditionally proposed cognitive modalities, and that VR techniques are able to capture these additional capacities.

Within a function-led approach, it is necessary to select the functions, or behaviors, to target. With the aim of finding mechanisms underlying the social aspects of psychosis, it might be worthwhile assessing relevant symptoms, as expressed in a naturalistic environment. As opposed to, for example, assessing a context-free impairment in emotion recognition, it may be more informative to track (mal)adjustment in a realistic situation where it is required to understand another's feelings or intentions. With respect to studies on social dysfunction in psychosis, this would imply a shift in focus towards assessing psychotic symptoms in a naturalistic social space. Most VR studies targeting mechanisms of psychosis do so by assessing paranoid experiences in representative and appropriate virtual environments (Valmaggia et al., 2016). For example, some studies investigated paranoia in naturalistic virtual environments (such as a train ride, or a bar) with ambiguous social cues (e.g., (Freeman et al., 2008; Veling et al., 2016). Such studies have the benefit of both full control over the experimental set-up and high real-life representation. In this way, they are able to assess the relation between known contextual and social factors and paranoid experiences with high ecological validity.

One limitation of contemporary VR is that it presents virtual avatars with which the user has had no previous contact. As such, the embeddedness of a social interaction in previous experiences (a key feature of real-life social situations) is not considered in VR. An additional important point is that realistic social interactions are not yet possible to render in VR (Pan & Hamilton, 2018). In the first place, this is because virtual avatars that have been developed so far are not truly life-like, neither in appearance nor in behavior. Secondly, although participants in VR studies interpret potential emotions and thoughts of virtual avatars, they never actually interact with them. This is an especially glaring limitation from a 'second-person' or embodied perspective of social cognition, which states that actual interaction is key to understanding social cognition, over and above any individual capacities.

Technological advances in artificial intelligence might provide a potential solution to these issues, by developing truly life-like virtual avatars. Still, even then it would be necessary to meet the generalizability criterion of ecological validity, and to assess whether results from VR studies do actually translate to real life. In order to learn more about social cognition or social functioning in the context of daily life, a method is needed that is able to most directly assess daily-life processes. A particularly well-suited candidate for achieving this is ESM.

4. Experience Sampling Methodology

ESM or Ecological Momentary Assessment (EMA; (Shiffman et al., 2008) is another methodology that has been increasingly used because of its high ecological validity (Hektner et al., 2007; Myin-Germeys et al., 2018). Via booklets, dedicated devices, or smartphone applications, this structured diary technique prompts participants to complete brief questionnaires during the day for several consecutive days in order to map experience and behavior in real-world and individual contexts. These brief questionnaires include questions about individuals' current social context (i.e. 'Right now, who is with you?') and their appraisals of this context in the moment (i.e. 'Right now, I would rather be alone'). This method avoids recall bias, as participants are requested to refer to their thoughts and feelings as they occur in the moment. While laboratory settings typically use actors or standardized expressive faces to add a social component (Green et al., 2015), ESM inquires about the actual social contexts of participants, which can differ throughout the day and between individuals. Additionally, the naturalistic setting of ESM allows the assessment of multimodal information about emotions across different physical contexts (Myin-Germeys et al., 2009), instead of an isolated assessment of either facial expression or auditory cues in the same physical context (Henry et al., 2015).

Although several links between laboratory measures of social cognition and daily-life measures of social functioning have been implied, few studies have directly compared them. (Janssens et al., 2012) compared a traditional computer task assessing emotion recognition with daily life reports on social context and participants' appraisal of this situation as an indicator of social functioning. No association was found between performance on the emotion recognition task and different aspects of social functioning in daily life (amount of time spent in these social contexts and the appraisals of these contexts). The authors argued that emotion recognition tasks in laboratory settings do not capture the complexity of daily life, which is in line with aforementioned critiques on these types of laboratory tasks (Zaki & Ochsner, 2009). Furthermore, Schneider and colleagues (2020) have not found any significant association between traditional ToM tasks and social functioning as measured in daily life. They argue

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that more basic interactive abilities than social cognition are at the core of social interaction, providing evidence for the SIF hypothesis as opposed to the social cognition first hypothesis, as referred to earlier. Although comparative research is scarce, the few studies that have directly compared social cognition tasks in the lab with social functioning in daily life show that they are poorly related. An alternative view would therefore be to focus on mechanisms underlying social interactive abilities and measure these directly in daily life.

Although objective measurements in ESM (e.g. amount of time spent alone) provide finer-grained information about social situations throughout the day than questionnaire measures, they do not provide insight regarding potential mechanisms of social impairment. In order to study how social interactions are altered in psychosis, it is crucial to explore what drives social behavior and which thoughts and emotions are associated with this behavior. For example, current explanatory models of negative symptoms highlight the importance of impaired effort-based decision making, resulting in individuals with psychosis to engage less in rewarding situations (Barch et al., 2016). This has primarily been investigated with traditional social cognition tasks in laboratory settings, such as the Awareness of Social Inference Test (ASIT) (Green et al., 2012). In order to map subtle states and changes in behavior though, more insight could be gained from studies exploring subjective indicators in daily life.

In mapping transient affective states (Myin-Germeys et al., 2009, 2018; Palmier-Claus et al., 2011), ESM has shed new light on the conceptualization of negative symptoms in psychosis, especially asociality and social anhedonia (i.e., diminished pleasure experienced in company). For example, momentary experiences of positive affect in company seem intact in patients compared with controls (Oorschot et al., 2013). Further, while some studies have found a reduced interest for social contact in individuals scoring high on a social anhedonia scale (L. H. Brown et al., 2007; Kwapil, 1998), recent work has challenged and amended the concept of asociality (Kasanova et al., 2018). The latter study showed that patients who, as a group tend to be unemployed and single, are less often engaged in social contexts corresponding to work and family obligations (i.e. structured goal-directed contexts), but equally often in unstructured social situations such as conversations and visits. These studies therefore challenge the idea that patients have limited interest in social interactions in general (true asociality), but rather argue to look into specific social contexts and appraisals thereof in daily life.

ESM studies have also explored several mechanisms related to the development of positive psychotic symptoms in daily life. One of them is enhanced threat anticipation, a cognitive-affective bias towards threat, linked to attribution bias and information processing (Freeman et al., 2013). (Reininghaus et al., 2016)) found support for this mechanism in daily life, showing an association between

threat anticipation (likelihood of personal negative events in the future) and intensity of psychotic experiences. This study did not investigate whether threat anticipation was mostly related to other individuals, so direct inferences on the social component cannot be made. However, enhanced threat anticipation could inform about the way individuals appraise their (social) environment. This would therefore be a fruitful avenue for future ESM studies in elucidating how positive symptoms such as paranoia can develop from threatening social situations. ESM studies focusing on the mechanisms implicated in the development of psychotic symptoms have shown that a fine-grained mapping of everyday social life can provide detailed, individual information on social functioning, which is highly relevant for clinical research.

In sum, we have shown that the link between social cognition and real-life social functioning in psychosis is not as strong as would be expected given traditional views of social cognition. We highlighted several potential explanations for the difference between findings from traditional social cognitive tasks in a laboratory environment and findings from assessments of social functioning in daily life. From a methodological point of view, we argue that laboratory tasks lack ecological validity, whereas ESM uses individuals' actual real-world reports with personal connections and backgrounds in different physical environments.

However, ESM also has some methodological limitations that should be considered when using this method for assessment of social functioning. First, there is currently no consistency in the ESM items that are used across research groups. As a result, a different operationalization has been used across ESM studies to measure the same concepts (e.g., social functioning). Second, appraisals are often addressed with a single item (i.e. 'I like this company'), whereas questionnaires usually group together several items assessing the same construct to improve validity of the measure. Both aspects could be improved by conducting methodological studies with the aim to establish a validated composition of items that correlates with self-report questionnaires. Nevertheless, through individual moment-to-moment measurements, ESM still has many added benefits. For example, it allows for more reliable individual scores on actual social interactive capacities, and for variability measures throughout days or weeks. Last, we have shown that ESM can provide new insights into how we can conceptualize symptoms in psychosis, and elucidate their occurrence in daily life.

5. Conclusion and implications

In this chapter, we discussed the usefulness of the concept of social cognition within the context of daily life, with a specific focus on psychotic disorder. In order to do this, the ecological validity of traditional social cognitive tasks has been

compared with two methods having high ecological validity. We argued that clinical research would benefit most from focusing on social functioning, which has shown to be weakly correlated with social cognition. Hence, VR and ESM have been proposed as ecologically valid alternatives to study social impairments in psychosis. We have also raised the question whether social cognition is a prerequisite for social functioning. The few studies comparing social cognition with social functioning in daily life showed weak correlations between the two ways of measurement, yet only a few studies are available. If further investigations fail to support the assumed link between social cognition and social functioning, a paradigm shift would be needed. In this regard, an interesting alternative would be to explore the SIF approach.

Moreover, VR and ESM in itself can be used to target identified mechanisms. Research has started to use ecological momentary interventions (EMI; Myin-Germeys et al., 2016) to identify symptoms or patterns in real time and offer individually tailored feedback to change thoughts or behavior. An example in individuals with anhedonia was conducted by (van Roekel et al., 2017). They used ESM data to provide individually tailored lifestyle advice, which successfully increased positive affect and pleasure at one-month follow-up. A promising next step would be to implement this feedback in daily life, where it could directly target real-life social interactive capacities. Further, a recent study by Pot-Kolder and colleagues (Pot-Kolder et al., 2018) used VR for improving daily-life social impairments in patients with psychosis. In their intervention study in 116 patients with a psychotic disorder, they used VR combined with elements of cognitive behavioral therapy (CBT). Patients in the treatment group were exposed to social situations in VR (e.g., a supermarket), whilst engaging in typical CBT exercises such as challenging and exploring suspicious thoughts, and dropping safety behaviors. Using this set-up, a significant drop in momentary paranoid ideation and momentary anxiety was observed post-treatment and at six-month follow-up. However, the authors observed no significant change in actual social participation defined as time spent with others (measured with ESM). Although actual interaction with virtual avatars was restricted, this study is promising in combining ESM and VR.

There are some additional considerations with regard to the more ecologically valid methods such as VR and ESM. As mentioned, the generalizability criterion has not been assessed in most VR studies of social cognition or social functioning. Therefore, it is unclear whether disturbances found in VR actually translate to daily life. One way of addressing generalizability would be to determine whether findings found in VR studies converge with expected real-life counterparts. This was done, for example, in the supermarket task of Greenwood et al. (2016). For ESM studies, internal validity remains challenging. While ESM usually relies entirely on self-report in dynamically changing and uncontrolled environments,

it is difficult to pinpoint what exactly drives results from ESM studies. One way of addressing these issues, characteristic of both VR and ESM, would be to examine whether studies employing both techniques converge or show similar patterns. For instance, ESM could be an excellent candidate for checking the generalizability of VR findings. Conversely, since every aspect of the environment can be controlled in VR, hypotheses obtained through ESM studies could be replicated in a VR environment. This would be a fruitful avenue for future work, as there are no studies using this combination of methods in psychosis or any other field in mental health research.

In conclusion, we argue that VR and ESM would both be promising and necessary additions to laboratory studies assessing social cognition. Incorporating these two methods would cover a broader spectrum of components of social functioning than what has presently been covered. Finally, more research on elucidating correlations between traditional social cognition tasks and social functioning in daily life is warranted, as well as a discussion of their meaning for psychotic symptoms in daily life.

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Chapter 4:

Be(com)ing social: Daily-life Social Interactions and Parental Bonding

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Abstract

Parents are known to provide a lasting basis for their children's social development. Understanding parent-driven socialization is particularly relevant in adolescence, as an increasing social independence is developed. However, the relationship between key parenting styles of care and control and the micro-level expression of daily-life social interactions has been insufficiently studied. Adolescent and young adult twins and their non-twin siblings ($N = 635$; mean age = 16.6; age range = 14.2 – 21.9; 58.6% female; 79.5% in or having completed higher secondary/tertiary education; 2.8% speaking language other than Dutch at home) completed the Parental Bonding Instrument (PBI) on parental care and control. Participants also completed a six-day experience sampling period (10 daily beeps, mean compliance = 68.0%) to assess daily-life social interactions. Higher overall parental bonding quality (of both parents) related to more positive social experiences in daily life (e.g., belonging in company), but not to more social behaviors (e.g., being with others). Factor analysis indicated a three-factor structure of the PBI, with care, denial of psychological autonomy, and encouragement of behavioral freedom. Paternal care was uniquely predictive of better social experiences. These findings demonstrate how parenting styles may be uniquely associated with how adolescents experience their social world, with a potentially important role for fathers in particular. This complements the long-held idea of socialization through parenting by bringing it into the context of daily-life and it implies how both conceptualizations of social functioning and interventions aimed at alleviating social dysfunction might benefit from a stronger consideration of day-to-day social experiences.

Introduction

Within developmental psychology, the process of socialization has been defined as the acquisition of a wide range of skills necessary for successful functioning in the social community (Grusec & Davidov, 2010). Particularly during adolescence, socialization is a fundamental process, as adolescence represents a key period of developmental flux within individuals' social worlds. During this time, where sensitivity to the changing social environment is especially acute, adolescents become increasingly independent from parental influences and connect with non-family members on a deeper level (Arnett, 2001; Blakemore & Mills, 2014; DeVault et al., 1996). Although adolescents develop increasing independence, parents remain key influencers, shaping their children's social development (Collins & Laursen, 2013; Smetana & Rote, 2019).

Parental Care and Control

To understand which aspects of parenting are most important for children's socialization, it is worthwhile to focus on those types of parenting that are most predictive of maladaptive developmental outcomes. Early factor analytic work on different dimensions of parenting has identified two factors that are particularly impactful for psychosocial development and the development of psychopathology: one factor of affection, warmth, and *care*, and one factor on autonomy and *control* (Parker et al., 1979; Roe & Siegelman, 1963). This general distinction between supportive and controlling parenting has been directly translated, respectively, in the two subscales of parental 'care' and 'control' of the widely used Parental Bonding Instrument (PBI) (Parker et al., 1979). Whilst these subscales measure specific parenting styles, the authors of the PBI also suggest the computation of a global parental bonding quality score – defined by high care and low control scores.

Since its inception, however, the two-factor structure of the PBI has been questioned, as numerous subsequent studies have found support for a three-factor solution (Cox et al., 2000; Gómez-Beneyto et al., 1993; Kullberg et al., 2020; Murphy et al., 1997; Xu et al., 2018). In this three-factor solution, the original 'control' subscale is split into two general subscales: One subscale on overly controlling, psychologically intrusive parenting (akin to the concept of 'helicopter' parenting), and one subscale referring to parenting that refers more to the granting of behavioral freedom. The PBI is one of the most commonly used parenting measures¹ in psychiatric epidemiology (Enns et al., 2002; Eun et al., 2017; Neale et al., 1994; Raudino et al., 2013; Ravitz et al., 2010), and its (two or three) subscales have been linked to the development of a variety of psychopathology during adolescence, such as depression, (social) anxiety,

phobias, substance abuse, externalizing disorders and eating disorders (Eun et al., 2017; Martin et al., 2004; Raudino et al., 2013; Young et al., 2011).

Assessing Social Interactions in Daily Life

The mechanism linking parenting styles to psychopathology is most likely social in nature. Ample developmental research has described how parenting socializes children, and prepares them for engaging with others (Bowlby, 1969; Grusec, 2011; Smetana et al., 2006). This process is especially relevant during adolescence, as this is the period where more connection with peers is sought out (Steinberg & Morris, 2001), but also when most psychopathology first arises (Kessler et al., 2007).

Leading developmental theories posit how, in order to better understand (social) development, the relationship between higher-order, more macro-level factors (e.g., general parenting perceptions) and micro-level processes (e.g., daily social interactions) needs to be clarified (as in, e.g., the bioecological model, (Bronfenbrenner et al., 2007); or the dynamic systems approach, (Van Geert & Lichtwarck-Aschoff, 2005). Moreover, developmental contextual approaches (Lerner, 1991) contend that adolescent development cannot be understood apart from the different *naturalistic* contexts in which people find themselves – which means that more ecologically valid assessments of social processes might be needed. The interaction between person and day-to-day (social) environment is thus key for understanding how adolescents grow up. Yet, despite the acknowledged importance of both the interaction between micro- and macro-level processes, and of ecological validity, these aspects are often considered only to a limited extent.

A stronger consideration of micro-level, naturalistic processes is particularly relevant for assessing social processes. Day-to-day social behavior is dynamic and involves all senses. It is embedded within physical, external and internal contexts, comprising the history of previous interactions with different interaction partners (Zaki & Ochsner, 2009). Yet, this complexity is often neglected in traditional retrospective measures or laboratory tasks aiming to assess relevant social outcomes (Hermans et al., 2019). Questionnaires or laboratory assessments of social processes do not measure social interactions at the moment that they occur. As we generally are more interested in adolescents' functioning in the real world than in the lab, this means that traditional measurements do not target social outcomes of parenting at arguably in the most relevant context.

An apt solution to this issue is the Experience Sampling Method (ESM; Csikszentmihalyi & Larson, 1987; Myin-Germeys et al., 2018), which has been explicitly developed to capture *daily-life* processes. ESM is a type of intensive longitudinal method that

usually prompts participants several times a day for several days, at (semi-) random times, to report thoughts, feelings, and current context as they go about their everyday lives. By sampling at random times throughout one's day, an ecologically valid representation of any participant's (social) life in different naturalistic contexts can be obtained. A key advantage of this direct reporting is that it severely reduces recall bias – a critical issue in the assessment of social behavior (Forgas et al., 1984; Verbeij et al., 2021). As participants also complete these diaries when in social situations, ESM is suited for directly assessing characteristics of interpersonal interactions as they occur in a natural context (Bernstein et al., 2018). As such, this method allows for testing whether traditionally assumed associations – e.g., between parenting and adolescent social outcomes – are present when that outcome is assessed in the moment, in people's day-to-day lives.

In addition, a benefit compared to, e.g., observational methods, is that ESM allows for measuring participants' *experience* of situations, together with their reported behavior and context. A useful distinction that we make between the different measured characteristics of daily-life social interactions involve relatively *quantitative* or behavioral aspects (social behavior) versus relatively *qualitative* or experiential aspects (social experiences). The most direct way of assessing quantities of social experiences is to simply ask at every ESM prompt whether a participant is in the company of people, and if yes, what type of company they are in. At the same time, participants are asked how they feel about or experience their current company.

The relevance of targeting social processes with ESM in this twofold manner is highlighted by a study by Schneider and colleagues (2017), who compared scores on the widely used Social Functioning Scale (SFS; Birchwood et al., 1990) with social functioning indicators as assessed through ESM. They found the SFS to be significantly related to relatively objective social measures (such as % of time spent alone), but to a lesser extent with subjective social experiences. These findings imply that ESM allows for the measurement of relevant aspects of daily-life social interactions that are not fully captured by traditional scales. If we aim to better understand the fundamental relationship between parenting and daily-life social processes, it is therefore essential to target both the quantity and quality of day-to-day social experiences. Moreover, gaining more insight into this relationship requires a focus on parenting styles relating to care and control, as they can be expected to be strongly involved in socialization.

Parenting and Daily-Life Social Interactions

Some of the earliest seminal ESM work has already focused on the (changing) social behaviors of adolescents, finding, for example, how adolescents (dis)

engage and (dis)connect with their parents at different stages throughout adolescence (Csikszentmihalyi et al., 1977; Larson et al., 1996). A limited number of ESM studies since then have provided additional insight into the relationship between general parenting perceptions and daily-life social interactions, for example, through the lens of parental attachment security (Sheinbaum et al., 2015; Torquati & Raffaelli, 2004). Although attachment style is conceptually distinct from parenting styles, they are related in the sense that attachment security is hypothesized to be largely shaped through parenting styles (Grusec & Davidov, 2010; Maccoby & Martin, 1983) – this hypothesis is supported by studies reporting associations between PBI styles and attachment (K. Berry et al., 2007; Manassis et al., 1999; Mulligan & Lavender, 2010; Tait et al., 2004). One of the key outcomes of successful socialization – social functioning – is defined in part by engagement in social behaviors (Birchwood et al., 1990; Cornblatt et al., 2007). Perhaps surprisingly, therefore, these ESM studies demonstrated no significant associations between secure attachment and any quantity of social behavior (i.e., being alone less, being with close others more). However, they did indicate that more securely attached young adults generally felt more positive emotions when with others and appraised their social contacts as more positive (Sheinbaum et al., 2015; Torquati & Raffaelli, 2004). This, in turn, is an indication that adaptive parenting styles – as correlates of attachment security – are also likely associated with positive experiences of daily-life social interactions.

Another one of the limited set of studies on parenting and daily-life social experiences has reported potential buffering effects of positive parenting behaviors on the emotional reactivity of (young) adolescents to negative, daily-life peer events (e.g., a disagreement with a friend) (Oppenheimer et al., 2016). Although parenting style and parenting behaviors are different concepts (parenting style has been referred to as the “emotional climate in which the parent’s behaviors are expressed”; (Steinberg & Darling, 1993), these findings highlight the value of associating general parenting factors with momentary social processes. However, given the domain-specificity of parenting – where specific types of parenting foster specific developmental outcomes (Grusec & Davidov, 2010) – it is also worthwhile exploring whether there are differential effects of discrete parenting styles on social processes. Here, we thus focus on parental care and control. Moreover, previous work has reported how care and control as experienced by a mother vs. father figure may have different developmental outcomes (Enns et al., 2002) – highlighting the relevance of investigating maternal vs. paternal factors on daily-life social processes.

This study aims to investigate the general and differential associations between perceived maternal and paternal parenting styles and naturalistic social behavior and social experiences. As such, we aim to complement research on the socialization effects of parenting by assessing the underlying alterations in social

interactions in the context of day-to-day life. Naturalistic social behavior is herein conceptualized as reports of, in principle, observable information (e.g., reports of being alone), while naturalistic social experiences are defined through items that ask for an evaluation of social situations (e.g., 'How safe do you feel in this company?'). To assess the specificity of effects for social vs. solitary situations, similar evaluations are measured when people are alone (e.g., 'How safe do you feel being alone?').

Hypotheses

Based on previous research, we expect that generally lower global parental bonding quality (i.e., low care and high control) is associated with less daily-life social behavior (e.g., less time spent with others/increased time spent alone) and more negative social experiences (e.g., feeling less at ease in the company of others). We will also explore the associations between global parental bonding quality and the experience of being alone. Potential differential effects of perceived parenting styles – both in terms of different styles and while considering maternal vs. paternal bonding – on social behaviors and social experiences are explored. Since no consensus currently exists on the factor structure of the PBI, and since the between-person relationship between parental care/control and social processes specifically at the level of daily life has not been investigated previously, all analyses in the current sample involving PBI subscales are considered exploratory.

Method

Participants

The current sample was recruited as part of the TwinssCan study, a longitudinal twin study that was developed to investigate gene-environment interactions in the development of psychopathology in adolescent twins and their siblings. All participants were recruited through the East Flanders Prospective Twin Study (Derom et al., 2019), a prospective and population based twin registry that started in 1964. Adolescent members of this registry (between 15 and 18 years old) were contacted via letters and invited to participate, along with their twin and non-twin siblings (between 15 and 34 years old). Adolescents could not participate if they had a pervasive mental disorder as indicated by a caregiver, and data was excluded if, during the test session, the test leader indicated that a participant was unable to complete the measures. The study comprised a number of questionnaires, interviews, and experimental tasks, all described in more detail elsewhere (Pries et al., 2019).

Before data were analyzed, $n = 52$ participants were removed because of insufficient compliance to the ESM protocol (i.e., a compliance $<30\%$). Of the remaining $n = 778$ participants, 104 participants indicated that they did not live with their parents or family. This study specifically focuses on the association between parenting and social functioning in daily life, and that relationship is likely to differ among people living at home vs. living elsewhere. Participants that still live with their parents will have relatively more structured social environments than participants who live independently. Therefore, we tried to make the sample as homogeneous as possible in terms of the social environment by removing these 104 participants from the dataset.

In addition, we were mainly interested in the (mid- to late) adolescent population, as this represents a key period of social development. Although the upper age limit of adolescence is debated, most contemporary definitions place it somewhere between ages 20 and 25 (Sawyer et al., 2018). To still have a relatively homogenous sample, we decided to remove all remaining participants over 21 years of age ($n = 39$). This resulted in a total sample size of 635. With this sample size, and with the repeated measurements design, there are sufficient data points in this dataset for most practically significant effects to emerge as statistically significant. The study was approved by the local ethics committee (Belgium, 'Commissie Medische Ethiek van de Universitaire Ziekenhuizen Leuven; No. B32220107766, project title 'Twinsscan'), and all participants provided informed consent prior to commencing the study. Parents of participants under 18 also provided informed consent.

Measures

Demographic Information.

Available demographic information for study participants were on education level, subjective social status, and languages spoken at home. For educational level, participants were asked about their highest educational degree. One participant indicated having a primary education degree; $n = 37$ were in or had completed vocational secondary education ('MAVO/VMBO' in the Dutch secondary education system); most participants ($n = 411$) indicated being in or having completed higher-level secondary education ('HAVO/VWO'); one participant reported lower-level vocational education ('LBO'); $n = 71$ reported mid-level vocational education ('MBO'); $n = 65$ reported a bachelor's degree; and $n = 32$ reported a master's degree.

As a measure of 'subjective social status', participants were presented with an adapted and translated version of the MacArthur Scale of Subjective Social Status (Adler et al., 2000; Klippel et al., 2018). In this task, participants were

presented with a drawing of a ladder with ten rungs, and were informed how each rung on that 'social ladder' represents the position that people have in their community. Participants were then asked to indicate their own position on this ladder for the community most important to them on a 0-100 visual analogue scale. Mean score on this scale was 36.7, the median was 50.0, and the standard deviation was 27.5.

Of the included sample, 18 indicated speaking another language at home besides Dutch. Of these 18, the specified languages were French ($n = 5$), English ($n = 4$), Spanish ($n = 2$), Chinese ($n = 2$), German ($n = 2$), and Algerian, Arabic, Berber, and 'dialect' (all $n = 1$). No information on ethnicity or cultural/geographic background was available to us for this sample, but the relative lack of other languages spoken at home does imply a relatively homogeneous, Dutch-background sample.

Parenting Styles.

The Parental Bonding Instrument (PBI) was originally developed to assess the perceived quality of the parent-child relationship along two main dimensions: Care and Control (Parker et al., 1979). It consists of 25 sets of two items (for both the maternal and for the paternal relationship) and asks about the quality of the relationship with each parent during the first 16 years of one's life. An example of a care item is 'Frequently smiled at me', while an example of a control item is 'Invaded my privacy'. Answers range from 0 ('Very unlike') to 3 ('Very like'). Global parental bonding quality scores were computed by summing both paternal and maternal care scores with both reversed paternal and maternal control scores (as per Parker et al., 1979).

As a number of previous studies have questioned the originally proposed two-factor structure of the PBI and have instead reported results indicating that a three-factor structure is more appropriate (Cox et al., 2000; Cubis et al., 1989; Gómez-Beneyto et al., 1993; Kendler, 1996; Murphy et al., 1997; Terra et al., 2009; Xu et al., 2018), we decided to perform a Factor Analysis (FA) on the PBI items for this sample to assess which factor structure best reflects the data, and subsequently, to decide how to construct the PBI subscales. The long-term stability (i.e., up to 20 years) of the PBI scores has been reported as being high, when the first assessment was either in adulthood or in childhood (Lizardi & Klein, 2005; Murphy et al., 2010; Wilhelm & Parker, 1990).

Experience Sampling Method (ESM).

In the current study, participants were asked to complete a 57-item ESM questionnaire ten times daily for six days. To maximize representativeness of the

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assessment period, the six-day assessment period always included both week and weekend days, and did not include major life events or large alterations from one's ordinary, day-to-day life. Six days is similar to the assessment periods used in other ESM youth studies, while ten daily beeps is higher than the number of daily beeps in most other similar studies (van Roekel et al., 2019). The prompt design was signal-contingent with random intervals. This means that the questionnaire was presented at random moments within ten daily 90-minute intervals, between 7.30 AM and 10.30 PM each day. When the Psy-mate ©, a custom-made Personal Digital Assistant (PDA) (Myin-Germeys et al., 2011) beeped, there was a 15-minute period to complete the questionnaire. All items that are used in the current analyses related to in-the-moment experiences of participants. All participants that were analyzed in the current study completed at least 30% of all beeps (as recommended in (Delespaul, 1995). Due to technical difficulties with the PDA in the regular ESM week, some participants completed the ESM for a few additional days. As such, six participants reported more than the normal maximum of 60 beeps, with a maximum of 76 beeps completed by one participant.

Quantity of Social Behavior.

At each ESM prompt, participants had to report their current social company on the item "Who am I with?" with the following answer options: 'No one', 'Partner', 'Relatives living in the same household', 'Other relatives', 'Friends', 'Colleagues', 'Acquaintances', 'Strangers', and 'Pets'. It was possible to select multiple answer options. Based on this item, a series of variables reflecting the quantity of social behavior were constructed : 1) 'being alone' (1 = being alone, 0= being with others,); 2) 'being with familiar people' when in the company of others, (1= being with a partner, any relative, or friends , 0 = being with colleagues, acquaintances or strangers only); 3) 'being with less familiar people' when in the company of others (1= being with colleagues, acquaintances, or strangers, 0=being only with a partner, any relative, or friends). When participants indicated that they were both with familiar and less familiar people, they would score a '0' on the first variable, and a '1' on the second and third variable. This also means that overlap is possible between 'being with familiar people' and 'being with less familiar people'. Being solely in the company of a pet was classified as being alone.

Most conceptualizations of social functioning also include aspects of being active, being involved in leisure activities, and being out of the house (as in, e.g., Birchwood et al., 1990; Cornblatt et al., 2007). These first two aspects were measured in ESM with the item 'What am I doing? (right before the beep)'. The variable 'doing nothing' was defined as 1 = doing nothing, 0 = doing something. The variable 'leisure activity' was coded '1' when either the answer option 'Passive

leisure' or 'Active leisure' was selected for the activity item, and alternatively, '0'. Finally, based on the item 'Where am I', the dichotomous variable 'at home' was scored as 1= at home, 0 = outside home.

Social and Solitary Experiences.

When people were in the company of at least one other person, they were presented with five items to assess their experience of the social situation: 'I would prefer to be alone'; 'I find this company pleasant'; 'In this company, I feel safe'; 'In this company, I feel judged'; 'In this company, I belong'. When people indicated that they were alone, they were presented with three items that evaluated their experience of being alone: 'I find being alone pleasant'; 'I would like to be in the company of other people'; and 'I feel safe'. All of these items were rated on a Likert scale ranging from 1 ('Not at all') to 7 ('Very'), and they were all directly and separately included in the analysis as dependent variables.

In ESM studies, Intraclass Correlation Coefficients (ICC) refer to the proportion of the total variance that is due to between-person differences. ICC values for the ESM items that we used were: preferring to be alone = .22; finding company pleasant = .26; feeling safe in company = .30; feeling judged = .38; feeling belonging = .29; pleasant being alone = .38; preferring company = .39; feeling safe alone = .40. These ICC values are similar to what is normally reported in intensive longitudinal studies (Bolger & Laurenceau, 2013).

We also computed both the between-person correlations between these items (by assessing correlations between the person means), and the within-person correlations (by assessing the correlations between the items after having been person-mean-centered). Between-person correlations ranged between .14 and .47 for the solitary experience items, and between .33 and .77 for the social experience items. The lower correlations for the solitary items indicate sufficient divergent between-person validity, while some of the higher correlations between the social items indicate that mean levels of some items are quite similar (the high correlation of .77 was between mean 'finding company pleasant' and mean 'feeling belonging in company'). Within-person correlations ranged between .08 and .33 for the solitary experience items, and between .17 and .39 for the social experience items. These low to moderate correlations support the within-person divergent validity of these items, as they do not appear to measure the same thing at any given time point.

At every beep, participants were also presented with a number of items relating to affect. Positive affect (PA) items consisted of: 'I feel cheerful/relaxed/satisfied/enthusiastic', and 'Generally speaking, I feel well'; negative affect (NA) items were: 'I feel insecure/lonely/anxious/annoyed/listless/down/guilty' (items were based on the Positive and Negative Affect Schedule; (Watson et al., 1988).

At each beep, a mean PA and a mean NA variable was created by averaging the scores on the respective PA and NA items. Cronbach's alpha values were calculated using the person-centered affect items, resulting in alpha values of .71 and .65 for the PA and NA scales, respectively – indicating adequate internal consistency of these items. The ICC for the PA variable was .36, and .41 for the NA variable. The between-person correlation and the within-person correlation between PA and NA were both -.41.

Statistical Analyses

For the analyses, we first investigated the effects of the total parental bonding score (across dimensions and across parents), before assessing the independent effects of more specific parenting styles per parent. As the ESM data have a hierarchical, three-level structure, with beeps nested within participants and participants nested within families, multilevel mixed-effects models were used with random intercepts (as in e.g., (Vaessen et al., 2017)). Multilevel modelling is a suitable method both for analyzing ESM-level data (Bolger & Laurenceau, 2013), and for clustering individuals in twin pairs (Guo & Wang, 2002; Hunter, 2021; Tamimy et al., 2021). As such, we account for the fact that observations from the same person are more similar to each other than to observations from other people, and family members (both twin and non-twin siblings) are more similar to each other than to other participants.

To assess the extent to which the total parental bonding score is associated with daily life social behaviors and experiences, separate multilevel (three-level) multiple regression analyses were performed with the parental bonding score as a predictor of all 18 social behavior and experience measures. For the dichotomous quantity of social behavior variables (e.g., 'being alone'), multilevel logistic regressions were performed and for the ordinal solitary/social variables (i.e., the evaluation and affect items on a scale from 1 to 7), multilevel linear regressions were performed.

To identify which underlying factor structure fits the parental bonding data best, an Exploratory FA (EFA) was performed on the first 60% of the dataset using the 'psych'-package in R. This obtained factor structure was subsequently tested with a Confirmatory FA (CFA) on the remaining 40% of the sample (using the 'lavaan'-package in R), and the latent factors were used to construct new PBI subscales. This EFA and CFA are described in more detail in the Supplemental Materials.

Then, the unique effects of each of the obtained parental bonding scores were explored. Separate analyses were performed with each of the parental bonding quality scores entered simultaneously as predictors of daily-life affect, and of the social and solitary items, to identify their unique contributions in explaining these

experiences.

Also, because all analyses involve multiple significance tests, the conservative Bonferroni correction was applied (Bonferroni, 1950), resulting in an alpha value of $.05 / 18 = .003$ for the initial 18 comparisons, and of $.05 / 12 = .004$ for the additional analyses.

As the range of the PBI is much larger than that of the social variables, the coefficients resulting from the analyses would be very small (i.e., in the .00 - .02 range) and therefore not very informative. To enhance interpretability of the relative size of the effects, a simple transformation (division by 10) was applied to the global parenting bonding quality score, and each PBI subscale score.

In all models, age and gender were included as covariates. To assess whether any associations are largely driven by the relatively older part of the sample, all analyses were also performed on the subsample that was 18 years of age or younger at the time of testing.

Open Science Practices

Within the reporting of our study, we aim to adhere as much as possible to the reporting guidelines for ESM studies with adolescents (van Roekel et al., 2019). As the data that are used for this study originate from a pre-existing dataset, this reporting is not possible for every item on that checklist. This study was not preregistered, but in order to maximize transparency of the current study, we have shared materials, code, and analytic output on the OSF-page for this project (<https://osf.io/xbfpe/>). Data are not publicly available.

Results

Descriptives and covariates

Descriptive statistics of all included variables are presented in Table 1, correlations between the PBI subscales are presented in Table 2, and all analyses are presented in Tables 3 and 4. Being older was significantly associated with more reports of being alone, less reports of being with familiar persons, more reports of being with less familiar persons, and less reports of being at home. Female participants had fewer reports of being alone and doing nothing, less positive affect both when alone and when in company, fewer feelings of being judged when in company, and more reports of being with familiar people (Table 3).

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Table 1: Means, standard deviations, and medians of all included variables. N = 635.

	Variable	Mean (SD)	Median	Range
Demographics	Age	16.6 (1.5)	16.0	14.2 – 21.7
	Gender (%females)	58.0	-	-
	Number of completed beeps (out of 60)	40.8 (10.0)	41.0	18.0 – 76.0
Parental bonding	PBI – paternal care	27.6 (4.7)	28.0	10.0 – 35.0
	PBI – paternal DPA	8.4 (4.6)	8.0	0.0 – 27.0
	PBI – paternal EBF	5.6 (2.0)	6.0	0.0 – 9.0
	PBI – maternal care	24.6 (5.6)	25.0	3.0 – 34.0
	PBI – maternal DPA	7.8 (4.3)	8.0	0.0 – 27.0
	PBI – maternal EBF	5.7 (1.9)	6.0	0.0 – 9.0
	PBI – total score	109.3 (17.9)	109.0	42.0 – 149.0
Quantity of Social Behaviors (ESM)	%time alone ^a	19.1 (16.4)	16.0	0.0 – 90.7
	%time familiar persons ^b	95.5 (9.3)	100.0	31.8 – 100.0
	%time less familiar persons ^b	23.0 (18.8)	20.0	0.0 – 77.3
	%at home ^a	59.6 (19.0)	58.9	6.5 – 100.0
	%doing nothing ^a	2.3 (5.5)	0.0	0.0 – 43.2
	%in leisure activities ^a	48.0 (18.1)	48.9	0.0 – 97.6
Quality of Solitude (ESM)	Pleasant	4.5 (1.4)	4.5	1.0 – 7.0
	Safe	5.7 (1.0)	5.8	1.0 – 7.0
	Prefer to be in company	3.8 (1.4)	3.8	1.0 – 7.0
Solitary affect (ESM)	PA when alone	4.9 (0.8)	4.9	1.5 – 7.0
	NA when alone	1.9 (0.7)	1.8	1.0 – 5.3
Quality of Social Encounters (ESM)	Pleasant	5.7 (0.7)	5.7	3.0 – 7.0
	Safe	5.8 (0.8)	5.9	2.6 – 7.0
	Judged	2.3 (1.0)	2.1	1.0 – 6.4
	Belonging	5.9 (0.7)	6.0	3.1 – 7.0
	Prefer to be alone	1.8 (0.7)	1.7	1.0 – 5.0
Social affect (ESM)	PA when in company	5.1 (0.7)	5.2	2.6 – 6.7
	NA when in company	1.7 (0.5)	1.6	1.0 – 4.3

Note: DPA = Denial of psychological autonomy; EBF = Encouragement of behavioral freedom

^a Percentage scores were computed as such: (number of reports/total number of valid reports) x 100;

^b Percentage scores were computed as such: (number of reports/total number of valid reports when in the company of any other) x 100.

Table 2: Correlations between the six dimensions of the PBI.

	Paternal care	Maternal DPA	Paternal DPA	Maternal EBF	Paternal EBF
Maternal care	.40*	-.41*	-.21*	.44*	.20*
Paternal care		-.28*	-.46*	.28*	.47*
Maternal DPA			.63*	-.40*	-.14*
Paternal DPA				-.18*	-.33*
Maternal EBF					.54*

Note: DPA = Denial of psychological autonomy; EBF = Encouragement of behavioral freedom

* $p < .001$

Table 3: Results of multilevel regression analyses wherein the overall parental bonding score was used as a predictor, and in which age and gender (being female) were included as covariates. For all 'Quantity of Social Behaviors' items, multilevel logistic regression analyses were performed, while for all 'Quality and Affect' items, multilevel linear regression analyses were performed.

	Total parental bonding score			Age		Gender (ref = male)	
	β (SE)	<i>p</i>	β (SE)	<i>p</i>	β (SE)	<i>p</i>	
Quantity of Social Behaviors	Alone	.00 (.03)	.89	.14 (.04)	<.001*	-.25 (.10)	.018
	Familiar persons	.04 (.05)	.37	-.44 (.06)	<.001*	.16 (.18)	.38
	Less familiar persons	-.02 (.03)	.45	.13 (.04)	<.001*	-.07 (.10)	.51
	At home	.03 (.02)	.09	-.05 (.03)	.048	.01 (.07)	.90
	Do nothing	-.09 (.05)	.08	-.13 (.07)	.058	-.72 (.19)	<.001*
Quality of Solitude	In leisure activities	.03 (.02)	.09	-.03 (.02)	.23	-.07 (.07)	.30
	Pleasant being alone	.05 (.03)	.12	-.09 (.04)	.015	.05 (.11)	.68
	Feel safe	.14 (.02)	<.001*	-.00 (.03)	.86	-.12 (.08)	.17
	Prefer company	-.08 (.03)	.010	.10 (.04)	.012	-.01 (.11)	.94
	PA when alone	.07 (.02)	<.001*	-.05 (.02)	.011*	-.20 (.07)	.002
Solitary affect	NA when alone	-.08 (.02)	<.001*	.00 (.02)	.96	-.02 (.06)	.79
	Prefer alone	-.09 (.02)	<.001*	-.02 (.02)	.36	-.07 (.06)	.22
Quality of Social Encounters	Pleasant company	.14 (.01)	<.001*	-.01 (.02)	.52	.04 (.05)	.45
	Feel safe	.11 (.02)	<.001*	-.01 (.02)	.65	.15 (.06)	.017
	Feel judged	-.10 (.02)	<.001*	.02 (.03)	.43	-.27 (.08)	.001*
	Belong	.12 (.01)	<.001*	-.04 (.02)	.023	.01 (.05)	.83
Social affect	PA when in company	.08 (.01)	<.001*	-.04 (.02)	.024	-.20 (.05)	<.001*
	NA when in company	-.07 (.01)	<.001*	.01 (.01)	.48	-.06 (.04)	.15

PA = average positive affect; NA = average negative affect
* α (bold) = .003; α (italics) < .05

Table 4: Results of multilevel regression analyses, in which the six perceived parental bonding dimensions, age, and gender were entered simultaneously as predictors of each experience and affect variable.

	Maternal care		Paternal care		Maternal DPA		Paternal DPA		Maternal EBF		Paternal EBF		Age		Gender (ref = male)	
	β (SE)	p	β (SE)	p	β (SE)	p	β (SE)	p	β (SE)	p	β (SE)	p	β (SE)	p	β (SE)	p
Quality of Solitude	.00 (.01)	.81	-.00 (.02)	.98	-.02 (.02)	.43	-.00 (.02)	.79	-.00 (.04)	.96	-.00 (.04)	.98	-.09 (.04)	.017	.03 (.12)	.76
	.00 (.01)	.72	.03 (.01)	.020	-.04 (.01)	.016	-.00 (.01)	.91	.01 (.03)	.69	.02 (.03)	.56	-.01 (.03)	.73	-.12 (.09)	.15
	.00 (.01)	.70	.01 (.02)	.36	.02 (.02)	.22	.03 (.02)	.08	-.07 (.04)	.11	.04 (.04)	.27	.11 (.04)	.006	.05 (.12)	.70
Solitary affect	.01 (.01)	.09	.00 (.01)	.76	-.00 (.01)	.68	-.01 (.01)	.53	.00 (.02)	.99	.03 (.02)	.21	-.05 (.02)	.016	-.20 (.07)	.004
	-.01 (.01)	.047	-.01 (.01)	.46	.02 (.01)	.07	.00 (.01)	.755	.04 (.02)	.08	-.04 (.02)	.035	-.00 (.02)	.97	-.01 (.06)	.86
Quality of Social Encounters	-.00 (.01)	.61	-.02 (.01)	.002	.03 (.01)	.028	.00 (.01)	.76	.03 (.02)	.18	-.02 (.02)	.25	-.02 (.02)	.40	-.06 (.06)	.32
	.01 (.01)	.08	.03 (.01)	<.001	-.02 (.01)	.043	-.01 (.01)	.10	-.03 (.02)	.066	.03 (.02)	.10	-.01 (.02)	.55	.03 (.05)	.57
	.02 (.01)	.013	.02 (.01)	.041	-.01 (.01)	.26	-.01 (.01)	.16	-.02 (.02)	.31	.02 (.02)	.46	-.01 (.02)	.81	.14 (.06)	.027
	.00 (.01)	.82	-.02 (.01)	.16	.02 (.01)	.20	.03 (.01)	.011	.04 (.03)	.14	-.02 (.03)	.38	.03 (.03)	.29	-.22 (.09)	.010
	.01 (.01)	.038	.02 (.01)	.002	-.01 (.01)	.27	-.02 (.01)	.037	-.03 (.02)	.10	.02 (.02)	.25	-.04 (.02)	.030	-.00 (.05)	.98
Social affect	.01 (.01)	.054	.01 (.01)	.44	-.01 (.01)	.17	-.01 (.01)	.23	.01 (.02)	.57	-.01 (.02)	.59	-.04 (.02)	.035	-.21 (.05)	<.001
	-.00 (.00)	.47	-.01 (.01)	.06	.03 (.01)	<.001	-.00 (.01)	.59	.03 (.02)	.10	-.03 (.01)	.018	.01 (.01)	.38	-.05 (.04)	.22

PA = average positive affect; NA = average negative affect; DPA = Denial of psychological autonomy; EBF = Encouragement of behavioral freedom
* α (bold) < .004; α (italics) < .05

Factor Analysis – PBI subscales

The factor structure that was identified in the FA was generally similar to that found in previous studies, where one factor comprised most of the original Care items, while the items of the original Control subscale generally loaded onto two factors (see Supplemental Materials for full description of FA procedure and results). These two latter Control factors have been labelled somewhat differently across studies. Generally, one factor has referred more to an overprotective type of controlling parenting emphasized by the authors of the PBI (Parker, 1983; Parker et al., 1979). The other factor contains items that focus more on the granting of behavioral autonomy. Since, content-wise, the FA results of this study were most similar to those reported by Murphy and colleagues (Murphy et al., 1997), we decided to also use their descriptors for labelling the factors, resulting in the three factors 'care', 'denial of psychological autonomy' and 'encouragement of behavioral freedom'. Denial of psychological autonomy here consists of six items that generally refer to parents' behaviors and attitudes that undermine their children's psychological autonomy and independence, and it consists of items such as 'Invaded my privacy' and 'Felt I could not look after myself unless he/she was around'. Encouragement of behavioral freedom consists of three items, such as 'Let me go out as often as I wanted' and 'Let me decide things for myself' – in contrast to the "denial of psychological autonomy" subscale, these items refer more to parents' allowing children/adolescents some freedom in their actual behavior. All new subscale scores were calculated by summing the Likert-scale responses (0-3) for every item that had a factor loading $>.3$ on both a maternal and paternal factor.

Reliability estimates were calculated for each new parental bonding dimension, resulting in the following Cronbach's alpha values: α (Maternal care) = .92; α (Maternal denial of psychological autonomy) = .77; α (Maternal encouragement of behavioral freedom) = .72; α (Paternal care) = .91; α (Paternal denial of psychological autonomy) = .79; α (Paternal encouragement of behavioral freedom) = .77. Correlations between all subscales can be found in Table 2.

Global Parental Bonding Quality Effects

Global parental bonding quality was not significantly associated with any of the quantity of social behavior variables (see Table 3). Among the items assessing solitary experiences, only 'feeling safe when alone' was predicted by the global parental bonding score. However, all items capturing social experiences were significantly associated with global parental bonding quality. When in company, higher global parental bonding quality was associated with a lower preference for being alone, finding the current company more pleasant, feeling safer, feeling less

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judged, and feeling more belonging (Table 3). Global parental bonding quality was also positively associated with positive affect and negatively with negative affect, both when participants were alone and when in the company of others.

Associations with Parenting Styles

To further investigate the effects of specific parenting styles on daily-life social experiences and affect, multilevel univariate regression analyses were performed with the six parenting styles (maternal/paternal care, denial of psychological autonomy, and encouragement of behavioral freedom) entered separately as predictors, in addition to age and gender (see Table 4).

There were a few unique significant associations between parenting styles and social experiences at the Bonferroni-corrected $\alpha = .004$. Higher levels of paternal care were associated a lower preference to be alone, more pleasantness of company, and with feeling more belonging when in company. More maternal denial of psychological autonomy was uniquely associated with more negative affect when in company (but not with negative affect when alone).

It has to be noted that we applied a relatively strict multiple comparison correction here, and that this has likely inflated the Type II error for these analyses. Under a more liberal $\alpha = .05$, there are more significant positive associations: between maternal care and both feeling safe in company, and feeling belonging. This is also the case for the relationships between maternal denial of psychological autonomy and preferring to be alone, paternal denial of psychological autonomy and feeling judged, and paternal care and feeling safe in company. Using an α -level of .05, there were also significant negative associations between maternal denial of psychological autonomy and finding current company pleasant, and between paternal denial of psychological autonomy and feeling belonging.

Sensitivity Analyses

To assess the effect of certain analytic decisions, we conducted a number of sensitivity analyses. The same analyses as outlined above were conducted on samples with (1) all $n = 778$ participants available in the original dataset (i.e., no age or living situation restriction); (2) $n = 674$ participants in the original dataset that were under 21 years of age, but without the restriction of living at home; (3) $n = 676$ participants of all ages in the original dataset who lived with their parents at the time of testing; (4) $n = 323$ participants under 16 years of age (all living at home); (5) $n = 312$ participants between 16 and 21 years of age (all living at home). In addition, all analyses were re-conducted with the twin-level removed as an additional third level in the multilevel analyses.

Although some of the marginally significant associations between specific

parenting styles and social experiences (per Table 4) became non-significant in some sensitivity analyses, none of the sensitivity analyses led to a substantially different interpretation of results. Code and output of all sensitivity analyses are available on the OSF-page of this study (<https://osf.io/xbfpe/>).

Discussion

In the current study, we uniquely assessed how parenting styles are associated with social behaviors and solitary/social experiences as they occur in the context of day-to-day life. Interestingly, global parental bonding scores were consistently associated with daily-life social experiences, but not with the number of social behaviors (e.g., amount of time spent alone vs. in company). When participants were alone, global parental bonding quality was also associated with feeling safe, indicating a more general parenting effect on feelings of safety. FA implied a three-factor structure in the parental bonding scale, generally loading onto factors of care, denial of psychological autonomy, and encouragement of behavioral freedom for both parents. Only perceived paternal care was uniquely and significantly associated with social experiences, namely with whether participants preferred to be alone when in company, how pleasant participants rated their daily company, and how much belonging they felt when in company. Neither denial of psychological autonomy nor encouragement of behavioral freedom was associated with any daily solitary or social experience.

These findings provide a greater understanding of how parenting relates to specific aspects of real-world social interactions as they occur in naturalistic contexts. In sum, we see that parenting is more closely related to how adolescents experience social situations, rather than to how much they interact.

Daily-life Social Behaviors

One possible explanation for the lack of association between global parental bonding quality and social behavior relates to the extent of control over one's social environment. In the current study, all participants still lived at home with their parents, and were 21 years of age or younger. Generally, adolescents/young adults living at home spend most of their time at home and school (in our sample; also, in (Csikszentmihalyi & Larson, 1984), where they might have limited control over the presence of social company. Alternatively, it might be that participants with lower global parental bonding quality spent less time with their parents, but that this was compensated by increased time spent with, e.g., friends or siblings. In the current study, we were unable to assess this hypothesis, as the ESM questionnaire did not assess whether participants were with their mothers and fathers specifically at each moment. For future research, it would be valuable

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to more specifically investigate the relationships between parenting styles and momentary experiences of parent vs. non-parent social interactions.

Daily-life Social and Solitary Experience

Although global parental bonding quality did not relate much to the quantity of social behavior in daily life, we did observe multiple significant associations between global parental bonding and the *experience* of everyday social situations. Higher-quality global parental bonding was associated with a lower preference for being alone when with others, but interestingly, not inversely related to an increased preference for being with others when alone. In addition, global parental bonding related to a generally greater likelihood of viewing the current company in a positive light, but not much to generally feeling better about being alone. These findings indicate the specificity of perceived global parental bonding on day-to-day *social* experiences, as opposed to *solitary* experiences.

Positive and negative affect when alone or in company were also associated with global parental bonding. Also, feeling safe when alone was the only solitary experience that was associated with global parental bonding, and this was the only solitary experience without a reference to being alone in the phrasing of the item (i.e., 'I feel safe' rather than 'I feel safe *being alone*'). These results suggest that early parenting experiences shape both how young people experience the everyday social interactions they engage in, and the overall feelings that they have in their everyday life. At the same time, however, global parental bonding quality does not seem to relate to specific appraisals of being alone, leaving the question open which factors do shape this momentary 'solitary satisfaction'.

Parental Control

We did not find evidence for an association between parental denial of psychological autonomy and any aspect of social experience. This finding is inconsistent with reports of associations between the related concept of parental psychological control and decreased well-being and distinct types of psychopathology (Barber & Harmon, 2004; Enns et al., 2002; Huppert et al., 2010; Martin et al., 2004; Weitkamp & Seiffge-Krenke, 2019). The process behind these associations has previously been hypothesized as psychological control involving an undermining of the sense of relatedness to parents and peers, which in turn would be expected to have a negative effect on (social) development (Soenens & Vansteenkiste, 2010). However, we report no evidence for such a process here.

We also did not find evidence for associations between parental encouragement of behavioral freedom and social experiences (when controlling

for the other parenting styles). This is consistent with other studies that also did not report any association between this parenting style and psychopathology (Kendler et al., 2000; Khalid et al., 2018; Otowa et al., 2013). Interestingly, however, a recent study by Kullberg and colleagues investigating the factor structure of a brief version of the PBI in a sample of adults with and without a lifetime affective disorder, found that those participants with any disorder reported lower levels of encouragement of behavioral freedom (Kullberg et al., 2020). Other studies on the related concept of autonomy support have also reported significant, unique associations between this parenting style and, for example, increased social competence (Soenens & Vansteenkiste, 2005), daily well-being (Van Der Kaap-Deeder et al., 2016), and both internalizing and externalizing psychopathology (Lansford et al., 2014).

One key difference between these previous studies and the studies employing the PBI is that these previous studies have generally used more extensive, validated measures of parental autonomy support or psychological control (Lansford et al., 2014; Soenens & Vansteenkiste, 2005; Van Der Kaap-Deeder et al., 2016). Therefore, to further investigate the potentially unique role of controlling parenting styles in shaping both children's and adolescents' socialization at the level of daily life and the development of psychopathology, it is worthwhile using measures that capture these distinct parenting styles more accurately.

Paternal Care

Perceived paternal care was the only parenting style with unique associations with a positive experience of day-to-day social interactions. This is in line with the idea that care aspects of parenting most directly fulfill the basic need for relatedness that people possess (Baumeister & Leary, 1995; Soenens et al., 2017). Earlier studies have identified factors relating to care (e.g., warmth, responsiveness) as highly impactful in several aspects of well-being. Studies investigating the link between parental care and psychopathology generally find associations between a lack of parental care and all types of internalizing and externalizing psychopathology (Enns et al., 2002; Ong et al., 2018). Other studies have identified further associations between care aspects of parenting and emotion regulation, social competence, peer acceptance in both children and adolescents (Barber et al., 2005; Davidov & Grusec, 2006; Rispoli et al., 2013).

In this study, we observed that if people perceive their general paternal care to be lower, they also tend to report lower belonging to the company that they are in in everyday life, and they rate this company as less pleasant. This might be an indication that the broad range of positive developmental outcomes that parental care is associated with, extends to more positively experienced naturalistic social

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interactions as well. Again, although exploratory, these associations between a (theoretically) invariable perception of parental care and variable, context-dependent social experiences confirm that such general parenting measures hold meaning at the level of everyday life.

The Potentially Unique Role of Fathers

Additionally, and in contrast to earlier studies, there were more (significant) unique associations between daily-life social experiences and *paternal* care than between such experiences and *maternal* care. This is discordant with earlier ESM studies, where the maternal relationship was generally perceived as more influential in adolescents' day-to-day lives (DeVault et al., 1996). It is also in contrast with previous similar studies that exclusively focused on the mother-child relationship (e.g., (Vanwoerden et al., 2015), or that primarily found unique effects of perceived maternal bonding on children's outcomes (Enns et al., 2002). Whereas historically, much parenting research has focused solely on mothers, the unique role of fathers has become increasingly recognized (Stolz et al., 2005). For example, emerging evidence suggests a potentially unique role of fathers' "autonomy- relevant" parenting in predicting later psychopathology (Lansford et al., 2014) – although other work has also emphasized the unique role of fathers' support (a similar concept to care) in predicting children's social initiative (Stolz et al., 2005), and of fathers' affection in predicting self-esteem (Marshall et al., 2021). Although these and the differential associations reported here all suggest a unique importance of the contemporary father's role for their children's development, the specific associations are different across samples. In order to better understand the unique contributions of mothers/fathers for children's socialization, a more idiosyncratic approach may be warranted, investigating specific social processes within individual families (Boele et al., 2019; Keijsers et al., 2016).

Limitations and Future Directions

The results of the current study must be interpreted within the context of its limitations. Firstly, although age was included as a covariate, the age range of the current sample was quite broad. Also, the items of the PBI refer to the parent-child relationship during the first 16 years of one's life. In the current sample, this means that for some participants their current situation is assessed, but for participants over 16, the instrument is retrospective. Although the PBI has primarily been used in studies with adult samples, it has also been used and validated in adolescent samples with age ranges similar to the sample in the current study (e.g, Cubis et al., 1989; Eun et al., 2017; Gullone & Robinson, 2005; Manassis et al., 1999;

Martin et al., 2004). Evidence exists for measurement invariance of the PBI across age groups (i.e., children vs. adults, (Tsaousis et al., 2012), indicating that the measure can be reliably used in younger age groups.

To assess whether the current results differed for the younger vs. older adolescents, sensitivity analyses were conducted on the $n = 323$ subsample of participants aged younger than 16, and on the $n = 312$ subsample of participants 16 and over. The main results of interest (associations between global parenting quality and five daily-life social experiences) were replicated in the younger subsample; in the older subsample, two out of five of these associations became non-significant (full results of these sensitivity analyses are included on the OSF-page of this project: <https://osf.io/xbfpe/>). These differences across subsamples may reflect how older adolescents are less dependent on their parents and may therefore be less affected by perceptions of parenting in their day-to-day social interactions – additional research is necessary to further examine these potential age differences. Still, the main conclusion based on these analyses did not change: In both subsamples, high parental bonding quality was generally associated with more positive social experiences, but not with more social behaviors.

The current study focused on cross-sectional associations between parenting and social experiences, and not on predictive relationships. Therefore, causal claims cannot be made. In line with the continuous interaction between micro- and macro-level developmental processes that is referred to in dynamical systems theory (Van Geert & Lichtwarck-Aschoff, 2005) and the bioecological model (Bronfenbrenner et al., 2007), it is likely that perceptions of past parenting are colored by the current situation, and that the momentary experience of social interactions is influenced by these past parenting perceptions. In order to assess both the potential direction of causality and the roles of person- and moment-level covariates, longitudinal and comprehensive ESM studies are valuable, as they allow for a better disentangling of the short- and long-term nature of socialization processes.

In addition, the ESM questionnaire used in the current study did not give participants the option to indicate whether they were in the presence of their parents at any given point. This made it impossible to assess the specificity of the reported effects. A recent daily-diary study suggests that general parent support positively affects day-to-day interactions with peers as well (Schacter & Margolin, 2019). For future work, it would be highly relevant to assess more specifically what parenting effects are manifested in different types of company. Furthermore, by virtue of being young and living at home, participants in this sample had relatively more structured social activity. It would be worthwhile to investigate whether the current findings replicate in older adolescent/young adult samples (e.g. up to 25 years of age, as per definitions of the “new adolescence”

[(Sawyer et al., 2018)]), where individuals are more likely to have control over the amount of social activity that they engage in. Finally, our measure of parental bonding was not explicitly designed to assess the parenting factors that we extracted from its items. As such, research is needed that uses psychometrically sound measures, particularly of controlling/autonomy-supporting parenting, to confirm the associations that we find here.

One unique added benefit of daily assessments in the study of parent-adolescent relationships, is that it allows for the investigation of within-family processes – and these processes may be opposite from between-family processes (Hamaker, 2012). For example, the authors of one recent study found how, generally, adolescents experienced greater negative mood on days when they experienced low parental support (Janssen et al., 2020). Surprisingly, however, this association was *reversed* in that same study for a small number of investigated families, for whom low parental support actually related to *less* negative mood. Findings such as these highlight the need for further investigating individual variability in daily diary studies. In the current study, we only investigated between-person differences, giving insight into the link between theoretically stable parenting dimensions of care and control (Steinberg & Darling, 1993) and social behaviors and experiences in daily life. However, it is also highly relevant to further elucidate what is happening at a micro-level time scale between specific controlling and caring parenting practices and social interactions on the day that those parenting practices are exhibited (for a recent review of such studies, see Boele et al., 2019).

Implications and conclusion

The distinction between social behavior and social experience identified in this study may be relevant for understanding more about the potential mechanisms that underlie the link between parental bonding factors and psychopathology. Different types of psychopathology have been linked to parental bonding (Enns et al., 2002), and most psychopathology is partially defined by disturbances in both the quantity (e.g., social isolation) and quality (e.g., social anxiety) of interpersonal interactions. This suggests that alterations in daily-life social interactions may help explain how parental bonding can lead to psychopathology outcomes. To this end, future research might first shed more light on the relative importance of objective versus subjective aspects of daily social interactions in the actual manifestation and development of psychopathology.

Additionally, the finding that parenting has more of an effect upon offspring's quality of social experiences rather than the number of social behaviors has potential implications for assessment of and intervention for social dysfunction. It indicates that traditional assessment tools of social functioning that largely

focus on the amount of social behavior may need to increase the emphasis on one's personal social experience, specifically in the context of parenting. Many social functioning measures focus mainly on quantifiable and observable information, yet this does not capture all relevant aspects of one's social world. In this way, adolescents who have experienced maladaptive parenting may appear to have intact social lives, while this may not be the case on a subjective level. The effectiveness of parenting interventions aimed at improving children's social functioning should therefore be judged not only based on changes in the amount of social behavior, but also on whether they relate to a more positive social experience.

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Chapter 5:

General Psychopathology and its Social Correlates in the Daily Lives of Youth

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Supplemental materials for this Chapter are available online: <https://osf.io/rjbdn/>

Abstract

Background: Adolescence is a period of both great social change and of vulnerability for psychiatric distress. However, little is known about the associations between early psychopathology and social interactions at the fundamental level of daily life. To better understand the social correlates of subclinical psychopathology in adolescence, we assessed associations between general psychopathology and the quantity and quality of daily-life social interactions.

Method: During a six-day experience sampling period, adolescent and young adult participants in Study 1 ($n=663$) and Study 2 ($n=1027$) reported the quantity and quality of their everyday social interactions. General psychopathology was assessed using the Symptom Checklist-90 and Brief Symptom Inventory-53. The relationship between psychopathology and each outcome variable was tested in separate multilevel linear and logistic regression models.

Results: General psychopathology was associated with social interaction quality. Associations between psychopathology and the number of social interactions were less apparent: In Study 1, participants with more psychopathology were not more alone ($B(SE) = .10(.11)$, 95%CI: $[-.12; .31]$, $p=.38$), whereas Study 2 participants with higher levels of psychopathology were alone more ($B(SE)=.39(.06)$, 95%CI: $[.27; .52]$, $p<.001$).

Conclusions: Consistent associations between subclinical psychopathology and the quality of social interactions support the fundamentally social nature of early psychopathology. Moreover, negative experiences of social interactions may be more valuable markers of early psychopathology than a reduced quantity of social behaviors. Conceptualizations of daily-life social functioning, and prevention/intervention efforts would benefit from considering the quality of everyday social experiences.

Introduction

Psychopathology is inherently social in nature. Ample epidemiological evidence suggests that different types of social risk factors are particularly strong predictors of the development and maintenance of a wide array of psychiatric disorders (Pickard et al., 2017; Sellers et al., 2019; Velthorst et al., 2017; Verboom et al., 2014). The role of social factors in psychopathology is especially relevant in adolescence – the age range between roughly 11 and 21 – as this is not only a critical period for social development (Blakemore & Mills, 2014) but also represents the age range where most psychiatric disorders have their first onset of symptoms (Kessler et al., 2007; Solmi et al., 2021). To aid early detection, and potentially prevent later mental disorders, it is imperative to understand the interpersonal factors that are associated with the development of psychological problems during adolescence.

Assessments of interpersonal factors involved in psychopathology (notably, social functioning) typically inquire about social behaviors and experiences at a single time point through retrospective self-report questionnaires or interview-based assessments (Birchwood et al., 1990; Cornblatt et al., 2007). Yet, such reflective measures do not account for several key aspects of real-life social interactions. Naturalistic social behavior is subtle, dynamic, shaped by information from all senses, and takes place in different contexts and with different interaction partners (Zaki & Ochsner, 2009). This complexity makes it difficult to capture the relevant aspects of naturalistic social interactions – and limits the grounding of many social measures in ‘real life’ (Albert & de Ruiter, 2018; Reader & Holmes, 2016; Risko et al., 2016).

To better understand the social correlates of psychiatric disorders, it is imperative to assess social processes as they manifest *in day-to-day life* (Bernstein et al., 2018). The Experience Sampling Method (ESM) is particularly suited to this endeavor, as it prompts people in their natural environments to report on their thoughts, feelings, behavior, and context multiple times a day via brief questionnaires (Csikszentmihalyi & Larson, 1987; Myin-Germeys et al., 2018; Shiffman et al., 2008), thus allowing for more ecologically valid assessments of (alterations in) day-to-day social interactions.

Previous ESM studies assessing the social correlates of psychopathology in patient populations have focused on alterations in both the quantity of social behavior (e.g., the amount of time spent with others), and its experiential quality (e.g., how comfortable one is when with others). As such, fewer social interactions and more negatively experienced social interactions have been reported for people with depressive, anxiety, and psychotic disorders (Collip et al., 2011; Snippe et al., 2016; Walz et al., 2014). One key question that these studies with patient samples raise is whether a diminished quantity and quality of social

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interactions can already be observed at an earlier, pre-clinical stage. Studying the relationship between psychopathology and daily-life social processes in adolescents who have not yet developed clinically relevant psychiatric disorders is paramount for better understanding the early development of psychopathology and for identifying early intervention targets.

Some previous ESM studies have already explored the social correlates of psychopathology in the daily lives of young adults (i.e., students) in the general population. Findings generally indicate that those with higher psychopathology levels experience naturalistic social interactions more negatively. For example, more negatively experienced social interactions have been linked to higher levels of positive schizotypy (Barrantes-Vidal et al., 2013; Kwapil et al., 2012), anxiety (L. H. Brown et al., 2007), and depressive symptoms (Brown et al., 2011). The relationship between subclinical psychopathology and actual social behavior – amount of time spent with others – is less consistent. Depressive symptoms (Brown et al., 2011), social anhedonia (L. H. Brown et al., 2007), and schizotypy (Barrantes-Vidal et al., 2013) (Barrantes-Vidal et al., 2013; Silvia & Kwapil, 2011) have been linked to fewer social behaviors, while other studies have reported no similar significant association for anxiety (Brown et al., 2007), psychosis-proneness (Husky et al., 2004), or schizotypy (Kwapil et al., 2012).

Although psychopathology is generally linked to more negative expressions in daily-life social interactions, some daily-life studies in general population young adults have suggested that people with higher levels of psychopathology may actually experience mood enhancement when in the company of others. A number of ESM studies have observed a larger decrease in negative affect (and a larger increase in positive affect) for young people with higher levels of depression or schizotypy when they were in the company of (close) people – as compared to people with lower psychopathology levels (Brown et al., 2011; Kwapil et al., 2012; van Roekel et al., 2014). Based on these findings, it is reasonable to hypothesize that adolescents with more psychopathology symptoms may also experience a ‘social sensitivity’ – or an increased affective benefit from being in the company of other people.

As these previous ESM studies on the relationships between psychopathology and daily-life social processes were largely in (young) adults, they leave open an important question: How are subclinical psychopathology symptoms related to the quantity and quality of daily-life social interactions – and to social sensitivity – for those in the crucial age period of adolescence? As mental disorder onset peaks around age 14 (Solmi et al., 2021), understanding the early social correlates of psychopathology is critical, both for better understanding the social development of mental health problems, and for informing early interventions.

Therefore, in this study, we aim to establish the relationship between self-reported psychopathology symptoms and the quantity (social behavior) and

quality (social experiences) of daily-life social processes in two of the largest adolescent samples to study this question to date. Our first study (Study 1) was a post-registered analysis (i.e., a form of pre-registration for pre-existing data; Benning et al., 2019) from a large youth twin study (Pries et al., 2019). To gain insight into the consistency of results across samples, we subsequently decided to conduct a conceptual replication of Study 1, in another independent, large adolescent sample – the SIGMA study (Study 2; Kirtley, Achterhof, et al., 2021).

For both studies, we hypothesize that higher levels of psychopathology are associated with both fewer social behaviors and more negatively experienced social interactions in daily life. To ascertain whether potential associations with psychopathology are specific to social situations, or instead, reflect a more general effect, we also investigate the link between psychopathology and the experience of moments when people are alone. Finally, we hypothesize that individuals with more psychopathology symptoms experience a social sensitivity or an increased affective benefit from being in the company of other people. Analyses in Study 2 are not pre- or post-registered but were performed as closely as possible to the post-registered Study 1 analyses.

Methods

Study 1

Participants

$N=778$ adolescent and adult twins aged 15–35 and their non-twin siblings were recruited as part of the TwinssCan study (for a full description, see Pries et al., 2019). The TwinssCan study included a battery of questionnaires and experimental tasks, in addition to ESM data collection. The study was approved by the local ethics committee (Ethics Committee Research UZ/KU Leuven, Nr. B32220107766). As the focus of this study is the adolescence period, participants over 21 years of age were excluded – in line with modern definitions of adolescence that extend its upper age limit to the early 20s (Sawyer et al., 2018). Participants who completed less than 30% of ESM questionnaires were also excluded (Delespaul, 1995; Trull & Ebner-Priemer, 2020). This resulted in a final Study 1 sample of $n=663$. Written informed consent was obtained from all participants, and from their parents, if subjects were younger than 18.

Demographic Information.

No information on ethnicity or cultural or geographic background is available for Study 1 participants. Eighteen participants indicated speaking a language other than Dutch at home, of whom six responded with a non-European language. These numbers imply that the Study 1 sample was relatively homogeneous in

terms of cultural/geographic background.

Measures

Psychopathology

The Dutch version of the Symptom Checklist-90 (SCL-90; Derogatis, Rickels, & Rock, 1976) is a self-report questionnaire consisting of nine subscales and 90 items with Likert scales ranging from 0 ('not at all') to 4 ('extremely'). The SCL-90 was used to construct a global psychopathology score, the Global Severity Index (GSI), which represents the mean across all SCL-90 items (Derogatis, 1994). This GSI had high reliability, with Cronbach's $\alpha=0.97$.

Originally, we intended to use the depression, anxiety and psychoticism subscale of the SCL-90. Since the factor structure of the SCL-90 has been called into question by previous studies (Cyr et al., 1985; Rytälä-Manninen et al., 2016), however, we first investigated the underlying factor structure of the SCL-90. Factor analysis subsequently indicated that the subscale factors were too highly correlated (between .91 and .95), and as such, insufficiently distinct (see additional factor analysis in Supplemental Material for more details). Therefore, only the GSI score was included as a predictor in all subsequent analyses.

Experience Sampling Method (ESM)

Participants answered ESM questionnaires on the PsyMate™, a custom-made Personal Digital Assistant (Myin-Germeys et al., 2011). In the six-day ESM period, participants received 10 prompts per day, between 7.30 AM and 10.30 PM, and each prompt contained a maximum of 57 items (subject to conditional branching). Participants had 15 minutes to respond to the questionnaire following each prompt. Participants were instructed to answer items by stating how they felt at the moment of the prompt.

Affect.

The ESM questionnaire had a number of affect items, phrased as 'I feel...', rated on Likert-scales ranging from 1 ('Not') to 7 ('Very'). Mean positive affect (PA) was calculated at each beep by averaging the scores on feeling cheerful, relaxed, satisfied, and generally well. Mean negative affect (NA) was computed at each beep by averaging scores of items on feeling insecure, lonely, anxious, and annoyed. As indicators of within- and between-person reliability, McDonald's Omega coefficients were calculated: $\omega_{\text{within}}=.64$ for PA, and $\omega_{\text{within}}=.51$ for NA; between-person reliability was $\omega_{\text{between}}=.90$ for PA, and $\omega_{\text{between}}=.81$ for NA. The intraclass correlation coefficient (ICC) for PA was .36, and for NA .41.

Quantity of Social Interactions.

Participants were asked at each prompt who they were with, and they could select one or multiple of different types of company. Based on this information, three dichotomous variables were computed: being alone; being with familiar people (partners, all relatives and friends); and being with less familiar people (colleagues, acquaintances, and strangers/others).

Quality of Social Interactions and Solitude.

When participants were in company, they rated their preference for being alone ($ICC=.22$), feeling belonging to the current company ($ICC=.29$), finding company pleasant ($ICC=.26$), feeling safe in company ($ICC=.29$), and feeling judged in company ($ICC=.38$). When participants were alone, they were asked to rate the pleasantness of being alone ($ICC=.38$), feeling safe when alone ($ICC=.41$), and preferring to be in company ($ICC=.40$). All solitary and social experience items were also rated 1 ('Not') to 7 ('Very').

Study 2*Participants*

$N=1913$ school-going participants aged 11-19 were tested as part of SIGMA, a longitudinal cohort study of adolescent mental health in the Flanders region of Belgium (Kirtley et al., 2021). During class time, participants completed a battery of questionnaires on a tablet computer and the following day, participants' ESM period started. All participants and parents provided informed consent, and all procedures were approved by the local ethics committee (METC KU Leuven S61395). Excluding participants with fewer than 30% ESM compliance resulted in a final Study 2 sample of $n=1027$.

Demographic Information.

As a proxy of national background, Study 2 participants were asked whether they felt any identification with any non-Belgian country or people, and $n = 186$ (26.1% of 713 completed responses) indicated explicitly that they felt like they belonged to at least one country other than Belgium.

Measures*Psychopathology.*

The abbreviated Dutch version of the SCL-90, the Brief Symptom Inventory-53 (BSI-53) (De Beurs, 2004), was administered, which was subsequently used for creating GSI scores for each participant (similar as for the SCL-90 in Study 1). Reliability for the GSI score was high (Cronbach's $\alpha=0.97$).

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Experience Sampling Method (ESM).

Participants were provided with a smartphone by the researchers with the ESM application 'mobileQ' (Meers et al., 2020) pre-installed. The length of the ESM period and its prompt schedule was the same as in Study 1, although participants in Study 2 had only 90 seconds to start responding to a questionnaire at each prompt. The full ESM questionnaire consisted of a maximum of 47 items.

Affect.

Mean PA and mean NA was measured and computed using the same items as for Study 1. Reliability coefficients are: $\omega_{\text{within}}=.73$ for PA, and $\omega_{\text{within}}=.62$ for NA; $\omega_{\text{between}}=.95$ for PA, and $\omega_{\text{between}}=.87$ for NA.

Quantity of Social Interactions.

Similar to Study 1, Study 2 participants were asked whether they were in the company of others at each ESM prompt. Three similar dichotomous variables were constructed: being alone; being with familiar people (all relatives, friends); and being with less familiar people (other peers, teachers, and strangers/others).

Quality of Social Interactions and Solitude.

When Study 2 participants were in company, they rated their preference for being alone (ICC=.33), feeling belonging to the current company (ICC=.37), feeling at ease in company (ICC=.35) and feeling appreciated by company (ICC=.43). When participants were alone, they were asked to rate the pleasantness of being alone (ICC=.56), a preference for being in the company of others (ICC=.47), and feeling excluded (ICC=.30). All items were similarly rated 1 ('Not at all') to 7 ('Very much').

Statistical Analyses

In each study, a series of multilevel regression analyses (with prompts nested in individuals, and for Study 1, also nested in twin pairs) was performed, with GSI as the (time-invariant) independent variable, and each (time-variant) social/solitary quantity/quality variable as the dependent variable. For the analyses involving the three (dichotomous) social quantity outcome variables, multilevel logistic regressions with varying intercepts were performed with the R-package 'lme4' (Bates, Mächler, et al., 2015). For the analyses with the eight (continuous) solitary/social experience as dependent variables, multilevel linear regressions with varying intercepts were performed using the R-package 'nlme' (Pinheiro et al., 2021). For every analysis, age and gender were included as covariates. No variables were centered before analyses.

For the social sensitivity analyses, two multilevel linear regressions with varying slopes were performed per study with moment-level social company, person-level psychopathology, and the interaction between company and GSI as independent variables, and PA and NA as dependent variables.

A Bonferroni correction was applied to each set of analyses (Bonferroni, 1950). For the initial psychopathology and social outcome analyses, $\alpha=05/11=.005$; for the social sensitivity analyses, $\alpha=05/2=.025$.

Open Science Practices

Analyses for Study 1 were registered online (<https://bit.ly/3uX53EQ>) following data collection, but prior to partial data access (Benning et al., 2019). All ESM social variables and demographic information had been accessed before analysis, but psychopathology information had not yet been accessed. Registration was also prior to the completion of data collection of Study 2 (and note that all analyses were identical in both studies). Deviations from the registration are described in the Supplemental Material. R code used for data manipulation and analysis, and full ESM questionnaires are available online on the OSF-page for this project (<https://bit.ly/3bAujcf>).

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Table 1: Descriptives of both studies

		Study 1 (n=663)			Study 2 (n=1027)		
	Variable	Mean (SD)	Median	Range	Mean (SD)	Median	Range
Demographic	Age	16.7 (1.5)	16.0	14.2 – 20.9	13.6 (1.8)	13.0	11.0 – 19.0
	Gender (%females)	58.2	-		65.1	-	
	# of completed beeps (out of 60)	40.8 (10.1)	41.0	18.0 – 76.0	31.6 (9.2)	31.0	18 – 59
Psychopathology (SCL-90 in Study 1; BSI-53 in Study 2)	Depression	8.6 (8.8)	6.0	0.0 – 61.0	0.8 (0.9)	0.5	0.0 – 4.0
	Anxiety	4.4 (5.2)	3.0	0.0 – 40.0	0.9 (0.7)	0.7	0.0 – 4.0
	Psychosis	5.7 (7.1)	4.0	0.0 – 52.0	0.7 (0.7)	0.4	0.0 – 3.2
	GSI	0.5 (0.4)	0.4	0.0 – 3.3	0.9 (0.6)	0.7	0.0 – 3.4
Social behavior (ESM)	%time alone ^a	19.3 (16.4)	16.0	0.0 – 88.6	13.6 (13.9)	9.3	0.0 – 100.0
	%time familiar persons ^b	95.5 (9.3)	100.0	31.8 – 100.0	90.0 (14.8)	96.2	0.0 – 100.0
	%time less familiar persons ^b	23.4 (19.0)	20.0	0.0 – 100.0	47.6 (15.8)	46.9	0.0 – 100.0
Social experiences (ESM)	Belonging	5.9 (0.7)	6.0	3.1 – 7.0	6.0 (0.9)	6.3	1.3 – 7.0
	Prefer to be alone	1.9 (0.7)	1.7	1.0 – 5.0	2.1 (1.1)	1.9	1.0 – 7.0
	Pleasant	5.7 (0.7)	5.7	3.0 – 7.0	-	-	-
	Safe	5.8 (0.8)	5.9	2.6 – 7.0	-	-	-
	Judged	2.3 (1.0)	2.2	1.0 – 6.4	-	-	-
	At ease	-	-	-	5.9 (1.0)	6.1	1.2 – 7.0
	Appreciated	-	-	-	5.8 (1.1)	6.1	1.0 – 7.0
Solitary experiences (ESM)	Pleasant	4.5 (1.4)	4.6	1.0 – 7.0	4.8 (1.8)	5.0	1.0 – 7.0
	Prefer to be in company	3.8 (1.4)	3.8	1.0 – 7.0	3.7 (1.8)	3.6	1.0 – 7.0
	Safe	5.7 (1.0)	5.8	1.0 – 7.0	-	-	-
	Excluded	-	-	-	1.4 (0.9)	1.0	1.0 – 7.0
Social affect (ESM)	PA when alone	5.2 (1.0)	5.2	1.0 – 7.0	5.3 (1.0)	5.4	2.0 – 7.0
	NA when alone	1.6 (0.8)	1.6	1.0 – 7.0	1.8 (0.7)	1.6	1.0 – 5.4
Solitary affect (ESM)	PA when in company	4.8 (1.1)	5.0	1.0 – 7.0	5.1 (1.3)	5.3	1.0 – 7.0
	NA when in company	1.9 (0.9)	1.7	1.0 – 5.3	2.1 (1.0)	1.8	1.0 – 7.0

GSI: Global Severity Index of both the SCL-90 and BSI-53, represents the mean item endorsement on the full SCL-90 and BSI-53.

^a Percentage was computed per person by dividing the number of reports of being alone for that person by the total number of valid reports for that person x 100;

^b Percentage was computed by dividing the number of reports of being in (less) familiar company by the total number of valid reports for that person being in the company of any other person x 100. Note that participants were able to indicate multiple types of company at each moment, and that these numbers therefore do not add up to 100%.

Results

In Table 1, descriptive statistics of all variables used in the current studies are presented. Notably, participants in Study 1 were older and had higher ESM compliance.

Psychopathology and Social Behaviors

Associations between mean psychopathology (GSI) and daily-life social behaviors are presented in Tables 2 and 3. In Study 1, mean psychopathology was not significantly associated with (the frequency of) being alone, nor with being with more familiar persons (Table 2). Higher psychopathology levels were associated with being more with relatively unfamiliar people. Conversely, in Study 2, higher psychopathology levels were associated with both being more alone, and with being less in the company of relatively familiar people – but not with the relative frequency of being with relatively unfamiliar people (Table 3).

Psychopathology and Social and Solitary Experiences

Higher levels of psychopathology were associated with every social experience that was assessed in either study. In Study 1, when those with higher psychopathology levels were in the company of others, they preferred to be alone more, found their company less pleasant, felt less safe, more judged, and less belonging in their company (Table 2). For Study 2, more psychopathology was associated with a greater preference for being alone when with others, and with feeling less at ease, less appreciated and less belonging in their (current) company (Table 3).

For solitary experiences in Study 1, psychopathology was a significant predictor of feeling safe when alone, but not of the other solitary experiences (see Table 2). In Study 2, participants were not asked about feelings of safety when alone, but instead, were asked about feeling excluded when alone (see Table 3). These feelings of exclusion when alone were associated with mean psychopathology scores, while psychopathology scores were not significantly associated with the other solitary experiences.

Social Sensitivity

Results of the social sensitivity analyses are presented in Table 4. The interaction between psychopathology and being in company was not associated with an altered increase/decrease in positive or negative affect in either sample.

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Table 2: Multilevel logistic and linear regressions in Study 1, predicting the quantity and quality of social encounters from psychopathology.

	Psychopathology				Age				Gender (female)				
	B (SE)	95% CI LL	95% CI UL	p	B (SE)	95% CI LL	95% CI UL	p	B (SE)	95% CI LL	95% CI UL	p	
Social Behavior	Being alone	.10 (.11)	-.12	.31	.38	.17 (.04)	.10	.24	<.001	-.30 (.10)	-.49	-.11	.002
	With familiar persons	-.45 (.18)	-.80	-.09	.015	-.43 (.06)	-.54	-.32	<.001	.30 (.17)	-.03	.63	.08
	With less familiar persons*	.34 (.11)	.13	.55	.002	.12 (.04)	.05	.20	.001	-.11 (.10)	-.31	.08	.26
Social Experience	Prefer to be alone	.43 (.06)	.31	.55	<.001	-.01 (.02)	-.05	.03	.53	-.17 (.05)	-.28	-.06	.002
	Finding company pleasant	-.39 (.06)	-.50	-.27	<.001	-.00 (.02)	-.04	.04	.82	.17 (.05)	.07	.28	.001
	Feel safe in this company	-.42 (.07)	-.54	-.29	<.001	-.00 (.02)	-.04	.04	.89	.25 (.06)	.14	.37	<.001
	Feel judged in this company	.52 (.09)	.35	.70	<.001	.04 (.03)	-.01	.10	.11	-.42 (.08)	-.57	-.26	<.001
	Feel like I belong in this company	-.43 (.06)	-.53	-.31	<.001	-.03 (.02)	-.07	.01	.14	.12 (.05)	.02	.22	.022
Solitary Experience	Pleasant being alone	.21 (.12)	-.02	.44	.09	-.08 (.04)	-.15	-.01	.027	.04 (.11)	-.18	.25	.74
	Feel safe	-.40 (.09)	-.58	-.22	<.001	-.01 (.03)	-.06	.05	.78	.00 (.08)	-.16	.16	.99
	Prefer company	.02 (.12)	-.22	.26	.87	.09 (.04)	.01	.16	.027	-.09 (.11)	-.31	.13	.40

P-values < .005 are below Bonferroni-corrected cut-off, and are displayed in bold; p-value < .05 are in italics. *This specific regression model was not included in the registration for this study.

Table 3: Multilevel logistic and linear regressions in Study 2, predicting the quantity and quality of social encounters from psychopathology.

	Psychopathology					Age					Gender (female)				
	B (SE)	95% CI LL	95% CI UL	p		B (SE)	95% CI LL	95% CI UL	p		B (SE)	95% CI LL	95% CI UL	p	
Social Behavior	Being alone	.39 (.06)	.27	.52	<.001	.23 (.02)	.18	.27	<.001		.07 (.09)	-.10	.24	.40	
	With familiar persons	-.45 (.10)	-.64	-.26	<.001	-.17 (.03)	-.23	-.10	<.001		.02 (.13)	-.24	.28	.89	
	With less familiar persons	.03 (.03)	-.04	.09	.44	.01 (.01)	-.01	.03	.36		.05 (.04)	-.04	.14	.27	
Social Experience	Prefer to be alone	.82 (.05)	.73	.91	<.001	.06 (.02)	.03	.10	<.001		-.14 (.06)	-.26	-.02	.025	
	Feel at ease in company	-.69 (.04)	-.77	-.61	<.001	-.05 (.01)	-.08	-.02	<.001		.14 (.05)	.03	.25	.012	
	Feel appreciated by company	-.67 (.05)	-.77	-.57	<.001	-.03 (.02)	-.06	.01	.13		.10 (.07)	-.03	.23	.14	
	Feel like I belong in company	-.65 (.04)	-.73	-.57	<.001	-.07 (.01)	-.10	-.04	<.001		.07 (.05)	-.03	.18	.16	
Solitary Experience	Pleasant being alone	.21 (.09)	.02	.40	.026	.04 (.03)	-.02	.04	.18		.29 (.13)	.03	.55	.026	
	Excluded when alone	.28 (.04)	.20	.37	<.001	-.01 (.02)	-.04	.02	.48		.01 (.06)	-.11	.13	.88	
	Prefer company	-.11 (.09)	-.30	.07	.24	.03 (.03)	-.04	.10	.37		-.13 (.13)	-.39	.12	.31	

P-values < .005 are below Bonferroni-corrected cut-off, and are displayed in bold; p-value < .05 are in italics.

Table 4: Multilevel linear regressions in Study 1 and Study 2 with psychopathology, company and the interaction between them as predictors, and Positive Affect (PA) and Negative Affect (NA) as the outcome variable.

	Positive Affect				Negative Affect			
	B (SE)	95% CI LL	95% CI UL	p	B (SE)	95% CI LL	95% CI UL	p
Study 1								
Total psychopathology	-.53 (.06)	-.65	-.40	<.001	.59 (.05)	.49	.70	<.001
Being in company	.21 (.03)	.16	.21	<.001	-.14 (.02)	-.18	-.09	<.001
Psychopathology * company	-.01 (.04)	-.09	.07	.87	-.03 (.03)	-.10	.03	.35
Study 2								
Total psychopathology	-.79 (.05)	-.89	-.69	<.001	.66 (.04)	.57	.74	<.001
Being in company	.08 (.05)	-.01	.17	.08	-.15 (.04)	-.23	-.08	<.001
Psychopathology * company	.03 (.04)	-.04	.11	.40	-.04 (.03)	-.10	.02	.21

P-values < .005 are below Bonferroni-corrected cut-off, and are displayed in bold

Discussion

The results of this large-scale investigation into the daily-life social correlates of psychopathology indicated that higher levels of psychopathology in adolescence were associated with more negative experiences of social interactions. The relationship between psychopathology and social behaviors was less straightforward: While psychopathology was significantly associated with more time spent with (familiar) others in Study 2, this was not the case in the relatively older sample of Study 1. This combination of findings implies that early psychopathology is broadly characterized by an altered experience of social interactions and that its relationship with quantities of social behavior is less apparent and might differ across populations.

Psychopathology Involves Altered Social Experiences in Daily Life

A first and important set of findings is that altered daily-life social experiences are associated with higher levels of subclinical psychopathology. This is in line with previous, similar ESM studies investigating specific social experiences and specific types of psychopathology (Barrantes-Vidal et al., 2013; Brown et al., 2007, 2011; Kwapil et al., 2012). The current study adds knowledge about the relationship between subclinical psychopathology and altered social experiences in three important ways. First, these results demonstrate that this link is robust across two large and independent samples from different countries. Second, whereas previous similar studies have largely focused on young adults (Barrantes-Vidal et al., 2013; Brown et al., 2007, 2011; Kwapil et al., 2012), we also observe links between psychopathology and altered daily-life social experiences in adolescence. This suggests how, when adolescents experience everyday social interactions more negatively, this could already be indicative of underlying psychiatric distress. Third, whereas previous studies have largely focused on a limited number of daily-life social experiences (e.g., a preference for being alone when in company; Barrantes-Vidal et al., 2013), we see broad associations of psychopathology with social experiences – not only with a preference for being alone, but also with finding company pleasant, feeling judged, appreciated, safe, at ease, and belonging. The consistent relationships between psychopathology symptoms and all aspects of social interaction quality may reflect the transdiagnostic relevance of social interaction quality. Future work could further identify at what stages of development, specific daily-life social experiences (e.g., feeling judged) become involved in the development of distinct types of psychopathology (e.g., social anxiety).

One could argue that those with more psychological symptoms experience

everything more negatively, and that therefore, this negative social experience is not specific to social situations. However, this interpretation is inconsistent with the current results. Psychopathology was not significantly related to a number of more negative experiences when alone, such as preferring company when alone or finding company less pleasant (although it did relate to feeling less safe and more excluded when alone). In contrast, psychopathology was associated with every social experience, across both independent samples. Therefore, this study highlights the fundamental and specific relationship between psychopathology and social experiences.

Inconsistencies in the Relationship between Psychopathology and Daily-Life Social Behaviors

The association between general psychopathology and the amount of social behaviors is less clear-cut. In Study 1, psychopathology was not related to being more alone, while this same association was significant in Study 2. The variability in this relationship reflects the variability in previous studies. In some samples of young adults, higher levels of specific types of psychopathology have been associated with more time spent alone in daily life (Barrantes-Vidal et al., 2013; Brown et al., 2007, 2011; Kwapil et al., 2012), while for other samples, those with more psychopathology were not more alone (Brown et al., 2007; Heininga et al., 2017; Husky et al., 2004; Kwapil et al., 2012). Note how the type of psychopathology is not necessarily predictive of being more alone vs. social – for example, positive schizotypy has been related to being both more (Barrantes-Vidal et al., 2013) and less alone (Kwapil et al., 2012).

These inconsistencies in the association between psychopathology and time spent with people are at odds with what might be expected from traditional views of social dysfunction. Most operationalizations of social functioning (Birchwood et al., 1990; Cornblatt et al., 2007) involve simply engaging in social activities. Yet, at the level of daily life, psychological distress is not necessarily related to being alone more. This implies that, in clinical assessments of social dysfunction, a high degree of engagement with others cannot be taken at face value as an indicator of adequate social functioning. Instead, the experience of social interactions needs to be considered as well.

Social Sensitivity

The current study did not show any evidence for a social sensitivity effect, as there was no altered affective response to being in company for those with higher psychopathology levels. One explanation for this finding is that social sensitivity is specific only to certain types of psychopathology, such as depression.

The greater sensitivity to social situations that was described by Brown and colleagues (Brown et al., 2011), for example, was interpreted as being caused by the depression-specific character trait of 'sociopathy', or social dependency (Coyne & Whiffen, 1995). It is possible that participants in the current study with mostly depressive symptom profiles did experience a greater sensitivity to social environments, but that this effect was obscured when we looked at the total psychopathology score only. Alternatively, social sensitivity may well involve a transdiagnostic process, but it is only apparent when adolescents are in company of people that they perceive as close (Brown et al., 2011; van Roekel et al., 2014). More research is needed to disentangle whether some people are more socially sensitive under certain circumstances.

Implications

Researchers have emphasized the inherently social nature of psychopathology for decades (Priebe et al., 2013; Schilbach, 2016; Sullivan, 1953; Vogeley & Vogeley, 2018). In this study, we aimed to pinpoint the social difficulties of adolescents at the most direct level of day-to-day social interactions. Across independent samples, adolescents with more psychological distress consistently felt less belonging, at ease, and appreciated in their day-to-day company. Moreover, the social nature of psychopathology was expressed more in adolescents' altered social experiences than in their decreased social behaviors.

These findings also may have notable implications for the conceptualization of social functioning. Traditional definitions and operationalizations of social functioning have strongly emphasized *quantities* of social behavior. For example, social functioning questionnaires tend to focus on having friends or engaging in social activities (Birchwood et al., 1990; Cornblatt et al., 2007). However, the current results demonstrate how – at the level of day-to-day life – the *quality* or the social experience might be a more relevant outcome to consider. Based on the current results, we argue that a transdiagnostic conceptualization of social functioning would benefit from a shift, from retrospective to daily-life assessments, and from social behavior to social experience.

Our findings indicate how early subclinical psychiatric symptoms may mostly manifest in altered social experiences. This implies that assessments of subclinical psychopathology and prevention efforts in youth would benefit from increased clinical attention toward altered social experiences in the daily lives of adolescents. Moreover, recent years have shown much promise for remotely delivered add-ons to psychological interventions that target problems in people's day-to-day lives, in the form of ecological momentary interventions (Heron & Smyth, 2010; Myin-Germeys et al., 2016a). When such daily-life interventions are used to target social dysfunction (Hanssen et al., 2020), the current study

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shows that it is imperative to not only assess and improve the quantity of social behaviors, but also the experiences of daily social interactions.

Strengths and Limitations

The current study has several strengths that contribute to a considerable level of confidence in the reliability of the reported results. This includes a substantially larger sample than those of most ESM studies, and the fact that we provide a direct in-paper conceptual replication in an even larger sample. Also, analyses for Study 1 were post-registered (Benning et al., 2019), a practice that is still relatively uncommon in psychiatry and clinical psychology research (Tackett et al., 2017), but allows for greater transparency, reproducibility, and replicability. This is particularly appropriate when analyzing large-scale and intensive longitudinal datasets involving many decision points, all of which represent potential researcher degrees of freedom (Kirtley, Lafit, et al., 2020; Simmons et al., 2011).

Some limitations also apply to this study. We initially intended to investigate the daily-life social manifestations of depression, anxiety, and psychoticism, but our measure of psychopathology inadequately captured distinct types of psychopathology. Consequently, we were unable to investigate the different social profiles of depressive, anxiety, and psychotic symptomatology. Study 2 was not designed as a replication of Study 1 and although we were able to conduct a conceptual replication, there are some methodological differences. Notably, Study 2 compliance was lower than Study 1 compliance. This is likely related to the response time: Study 1 participants had 15 minutes to respond to an ESM prompt, whereas Study 2 participants only had 90 seconds. We cannot exclude the possibility that such methodological factors also (partially) drive different results found across studies.

Conclusion

In the current study, we investigated the social manifestations of psychopathology in adolescents, when assessed at the crucial level of daily life. Psychopathology levels related mostly to the social experience of the day-to-day social environment, rather than the quantity of social behaviors. The reported discrepancy in social/solitary preferences when in a social vs. nonsocial context indicates that psychopathology manifests mostly when young people actually engage in a social interaction, rather than when they are alone. This is consistent with the idea of psychopathology being inherently social (Priebe et al., 2013; Schilbach, 2016; Sullivan, 1953; Vogeley & Vogeley, 2018). This study sheds light on the potential value of considering altered

social experiences in our conceptualization of social functioning, and in the identification of early intervention targets. We argue that to better understand the nature of psychopathology, interpersonal processes are key – and in order to capture social dysfunction that is relevant, it is crucial to use ecologically valid assessment methods. Doing so might bring us closer to developing interventions that actually target that space where people experience problems: In the arena of daily life.

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Chapter 6:

Daily-life Social Experiences as a Potential Mediator of the Relationship Between Parenting and Psychopathology in Adolescence

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Abstract

Adolescence is a vulnerable period for psychopathology development, and certain parenting styles are consistent and robust predictors of a broad range of mental health outcomes. The mechanisms through which maladaptive parenting styles affect the development of psychopathology are assumed to be largely social in nature. Yet, the social mechanisms linking parenting to psychopathology are unexplored at arguably the most important level of functioning: daily life. This study aims to identify the associations between three parenting styles, and the experience of daily-life social interactions. Furthermore, we aim to explore the extent to which these parenting styles and altered daily-life social experiences are associated with psychopathology.

In this study, we recruited a sample of $N = 1913$ adolescents (63.3% girls; mean age = 13.7, age range = 11 to 20) as part of the first wave of the longitudinal cohort study 'SIGMA'. Parenting styles (psychological control, responsiveness, and autonomy support) and psychopathology symptoms were assessed using a retrospective questionnaire battery. The experienced quality of social interactions in different types of company was assessed using the experience sampling method, ten times per day for six days.

Direct associations between parenting styles and general quality of daily-life social experiences were tested using a three-level linear model, revealing significant associations between social experiences and different parenting styles. When interaction effects were added to this model, we found that maternal responsiveness and paternal psychological control mainly related to altered qualities of social interactions with parents, while paternal autonomy support was associated with better experiences of non-family social interactions. Finally, an exploratory path analysis highlighted how both paternal autonomy support and altered quality of non-family interactions are uniquely associated with psychopathology levels.

These findings demonstrate the general and pervasive effects of maladaptive parenting styles, as parenting seems to broadly affect adolescents' interactions with different types of social partners in everyday life. Moreover, they illustrate a potential mediated relationship in which altered daily-life social interactions could drive the development of psychopathology. A stronger focus may be required on the role of altered day-to-day social experiences in the prevention and potentially, the treatment, of adolescent psychopathology.

Introduction

Mental health problems are strongly shaped by the specific manners in which children have been raised, as certain parenting dimensions are strong and robust predictors of a broad range of psychopathological symptoms. For example, concurrent and longitudinal evidence has emphasized the maladaptive effects on child and adolescent development of parental psychological control, which is characterized by control that undermines children's emotional experience and expression and involves, e.g., love withdrawal and guilt induction (Barber, 1996). On the other hand, more positive parenting has been described, for example, in terms of parental support or responsiveness, which represents parents' sensitive responses to situations when a child is distressed (Davidov & Grusec, 2006). Parental autonomy support is another type of parenting assumed to be positively related to children's adjustment, and is characterized by, e.g., parents' allowing their children to make their own choices, and acknowledging children's own perspective (Soenens et al., 2007). As such, these positive parenting dimensions are hypothesized to be associated with more adaptive psychosocial development. Ample previous research has highlighted how parental psychological control is a unique risk factor for the development of internalizing psychopathology (Barber et al., 1994; Barber & Harmon, 2004; Nelemans et al., 2019; Soenens et al., 2005; Weitkamp & Seiffge-Krenke, 2019), while parental responsiveness and autonomy support are protective against the development of psychiatric symptoms (Beyers & Goossens, 1999; Nelemans et al., 2019; Smetana, 2017).

Understanding the lasting impact of parenting styles on children's development is particularly relevant during adolescence, which represents the period where most psychopathology develops (Kessler et al., 2007). Adolescence is also a period of significant social change, when individuals develop independence as they move away from parents and toward peers (Smetana et al., 2006; Steinberg & Morris, 2001). As adolescents start interacting more and more with non-family members, however, those with experiences of adaptive parenting styles are expected to be best-equipped to engage with others. An adolescent who has been supported by their parents in the development of their autonomy is expected to feel comfortable seeking out this autonomy in their relations with others (Soenens & Vansteenkiste, 2010), and adolescents who have experienced responsive parenting can be expected to enter the social arena with a greater sense of security (Davidov & Grusec, 2006). Conversely, experiences of psychologically controlling parenting are thought to instill a sense of insecurity and negative self-perception, which, in turn, can be expected to spill over into social interactions with others (Barber & Harmon, 2004; Soenens & Vansteenkiste, 2010). As such, parenting styles help lay the foundation for how adolescents interact with other people as they venture into the world.

Healthy and positive social interactions with both family and non-family members are, in turn, considered as important protective factors for maintaining good mental health. Alternatively, when the described parent-driven socialization goes awry, psychopathology may develop. Fundamentally, the established link between parenting and psychopathology can be considered largely social in nature: parenting more generally affects adolescents' social interactions (Grusec, 2011) which, when they are consistently negative, can contribute to the development of mental health problems. However, while the relationship between parenting and psychopathology symptoms is often assumed to be mediated by altered social interactions, this has – to our knowledge – never been comprehensively explored in daily life.

Social correlates of parenting and psychopathology are usually assessed using retrospective self-report questionnaires. Although research that employs retrospective measures can be valuable for assessing general processes, it fails to consider several important aspects of social processes. Naturalistic social interactions are dynamic, context-dependent, fleeting, subtle, involve all senses, and as such, are difficult to capture outside of the real world (Hermans et al., 2019; Zaki & Ochsner, 2009). An alternative method that does allow for the capturing of social interactions in daily life is the Experience Sampling Method (ESM), also referred to as Ecological Momentary Assessment or EMA (Csikszentmihalyi & Larson, 1987; Myin-Germeys et al., 2018; Shiffman et al., 2008). ESM is an intensive longitudinal method in which participants are prompted multiple times per day to report on their momentary experiences, thoughts, feelings, and context as they go about their day-to-day lives. In assessing social processes in context, ESM allows for capturing both the relatively objective characteristics of day-to-day social interactions (i.e., who are you interacting with, and where?) and the associated subjective experience (i.e., how do you feel about the person you're with?).

To some extent, research employing ESM to study social processes has already identified how daily well-being and the quality of daily social interactions are linked to people's parenting experiences (Achterhof et al., 2020; Grusec, 2011; Schacter & Margolin, 2019), while there is also increasing evidence for the relationship between psychopathology symptoms and altered experiences of social interactions (Achterhof, Kirtley, Schneider, Hagemann, et al., 2021; Barrantes-Vidal et al., 2013; Brown et al., 2007, 2011). Interestingly, these studies indicate how, generally, both parenting experiences and psychopathology relate more to an altered *quality* of social interactions (e.g., feeling belonging to current company; preferring to be alone when with others) rather than to changes in the *quantity* of social behaviors. These findings suggest that the mediating role of social processes in the relationship between parenting and psychopathology can be reliably assessed at the level of daily life, and that this mediating role

is likely determined more by altered subjective social experiences than by differences in social behaviors. However, as the results of the studies pertained to all social interactions that participants reported on, these results lack some necessary specificity. Participants in ESM studies engage with different people throughout the sampling period – both with family and with non-family members. Parenting styles are likely differentially associated with social experiences when the associated social interactions pertain to family vs. non-family members. As discussed, to truly understand the impact of parenting on adolescents' socialization, it is imperative to specifically assess how parenting relates to the qualities of social interactions when adolescents interact with people outside of the family.

Therefore, in this study, we aim to test the associations between the parenting styles of psychological control, autonomy support, and responsiveness, and altered daily-life social experiences; and to investigate the specificity of the effects of maternal/paternal parenting styles on daily-life social interactions when participants are with parents vs. when with non-family members. Moreover, in examining these relationships, we will also consider differences in age and gender. As adolescents get older and achieve more independence, the relationship between parenting and psychopathology may weaken. At the same time, previous research has suggested how parenting styles are more strongly associated with psychopathology when they refer to the same-sex parent (Eun et al., 2017). Accordingly, we will also investigate whether the investigated relationships differ across genders and as a function of age.

Our registered hypotheses are as follows (see registration or supplemental material for full hypotheses as registered):

- 1 Perceived parental (maternal and paternal) **responsiveness** is associated with a more **positive** social experience in daily life, when also accounting for the proportion of time spent with mother/father.
- 2 Perceived parental (maternal and paternal) **psychological control** is associated with a more **negative** social experience in daily life, when also accounting for the proportion of time spent with mother/father.
- 3 Perceived parental (maternal and paternal) **autonomy support** is associated with a more **negative** social experience in daily life, when also accounting for the proportion of time spent with mother/father.
- 4 Perceived **maternal responsiveness** is associated with more **positive** experiences of **mother interactions** in daily life, when also accounting for the effects of maternal autonomy support, maternal psychological control, and paternal parenting styles.

4.1 This association is stronger than the association between maternal responsiveness and social experience when with non-family members.

5 Perceived **maternal psychological control** is associated with a more **negative** social experience of **mother interactions** in daily life, when also accounting for the effects of maternal autonomy support, maternal responsiveness, and paternal parenting styles.

5.1 This association is stronger than the association maternal psychological control and social experience when with non-family members.

6 Perceived **maternal autonomy support** is associated with a more **positive** social experience of **mother interactions** in daily life, when also accounting for the effects of maternal psychological control, maternal responsiveness, and paternal parenting styles.

6.1 This association is stronger than the association between maternal autonomy support and social experience when with non-family.

7 Perceived **paternal responsiveness** is associated with a more **positive** social experience of **father interactions** in daily life, when also accounting for the effects of paternal autonomy support, paternal psychological control, and maternal parenting styles.

7.1 This association is stronger than the association between paternal responsiveness and social experience when with non-family members.

8 Perceived **paternal psychological control** is associated with a more **negative** social experience of **father interactions** in daily life, when also accounting for the effects of paternal autonomy support, paternal responsiveness, and maternal parenting styles.

8.1 This association is stronger than the association between paternal psychological control and social experience when with non-family members.

9 Perceived **paternal autonomy support** is associated with a more **positive** social experience of **father interactions** in daily life, when also accounting for the effects of maternal psychological control, maternal responsiveness, and paternal parenting styles.

9.1 This association is stronger than the association between paternal autonomy support and social experience when with non-family members.

10 Perceived **maternal and paternal responsiveness** are uniquely associated with a more **positive** social experience of interactions with **non-family members**, when also accounting for the effects of the effect of maternal/paternal responsiveness and autonomy support.

11 Perceived **maternal and paternal psychological control** are uniquely associated with a more **negative** social experience of interactions with **non-family members**, when also accounting for the effects of maternal/paternal responsiveness and autonomy support.

12 Perceived **maternal and paternal autonomy support** are uniquely associated with a more **positive** social experience of interactions with **non-family members**, when also accounting for the effects of the effect of maternal/paternal responsiveness

and psychological control.

13 All reported effects are stronger for younger participants

14 All reported maternal effects are stronger for female participants; all reported paternal effects are stronger for male participants.

Responsiveness and autonomy support are hypothesized to have positive associations with the experience of social interactions, while for psychological control, we expect negative associations. In addition to testing these hypotheses, we conduct exploratory analyses using a comprehensive path model, where general psychopathology levels are associated with both parenting styles and mean social experiences when in company of mother/father/non-family, and where these social experiences in turn are associated with different parenting styles. Although studies with cross-sectional data preclude claims about the temporal sequence of events underlying mediation effects (Cole & Maxwell, 2003; Maxwell & Cole, 2007), they can be used to illustrate the contemporaneous associations that might form the basis for longitudinal mediation, which can be investigated in future longitudinal research.

Materials and Methods

Participants

A sample of $N = 1913$ adolescents were recruited and tested between January 2018 and June 2019 as part of the first wave of the longitudinal cohort study SIGMA (Kirtley et al., 2021). Participants were recruited for the SIGMA study through one of 22 participating secondary schools in the Flanders region in Belgium. Potential participants were briefed about the content of the study before they could voluntarily sign up, with permission of at least one parent or caregiver. There were no specific in- or exclusion criteria for this study, apart from the ability to read and understand Dutch.

At the time of testing, all participants were either in the first (roughly aged 12/13), third (aged 14/15), or fifth grade (aged 16/17) of the Flemish secondary education system. As the Flemish school system allows students to repeat school years, and because students who immigrated to Flanders may enter a grade at an older age, a small number of participants included in this study are over 18 (eight 19-year-olds; one 20-year-old). In line with modern definitions of adolescence (Sawyer et al., 2018), we retained these participants in the full sample.

No information on ethnic or geographic background, or on racial identity was collected. Asking about ethnic groups or racial identity specifically is relatively uncommon in Belgium, and to our knowledge, no standard ethnicity or racial

identity questions/response categories exist in Dutch (within Belgium/the Netherlands). Participants were asked whether they identified with any non-Belgian country, and 186 (26.1% of 713 responses to this question) responded with identifying with at least one country other than Belgium.

Procedure

The SIGMA study consisted of two main parts: Retrospective questionnaires and daily-life measurements. For the first part of the study, participants were administered a self-report questionnaire battery in one 100-minute session that they were asked to complete on a provided tablet computer in their own classroom. These questionnaires included, among others, those on parenting style and psychopathology that are used in the current study, but also questionnaires on social support, bullying, trauma, and other factors (for full questionnaire battery, see (Kirtley, Achterhof, et al., 2021). Each participant was asked to start completing the questionnaires at a different specific part of the questionnaire battery – thereby ensuring comparable missingness patterns across all questionnaires. When participants did not want to answer any specific item, they were given the option of answering ‘I do not wish to answer this question’.

At the end of this initial 100-minute session, participants were instructed about the second, daily-life part of the study. Participants were provided with a smartphone pre-installed with the MobileQ application (Meers et al., 2020), through which they would receive the ESM questionnaires for the following six days. Participants were instructed to go about their daily lives as usual throughout the ESM period, and to answer the random prompts whenever they were notified. They were also guided through the questionnaire by one of the researchers, to ensure that the content of every item was clear.

Each day in the ESM period, at semi-random times between 7.30 AM and 10.30 PM, participants received ten notifications on the provided smartphone asking them to complete a 45-item questionnaire on their mood, thoughts, behaviors, and context (see Supplementary Material available online for full ESM list; osf.io/rnu4s). The semi-randomness of this ESM design refers to the prompts being distributed at random times within each of ten 90-minute blocks. There was at least 15 minutes between consecutive prompts, participants had 90 seconds to respond to each prompt, and participants had 90 seconds to complete each individual item in the questionnaire. For all participants, the ESM period involved four school days and two weekend days. For ESM prompts sent out during class time, participants were given permission by the school and teachers to fill out these daily questionnaires in the classroom. After returning the study material at the end of the ESM period, participants were rewarded with

a 10-euro gift voucher.

Measures

Retrospective Questionnaires

Parenting Styles.

Questionnaires on parenting styles were adapted from three of the four subscales of the aggregated 'General Parenting Style' measure, which have been previously used in Dutch-speaking adolescent samples (Soenens et al., 2006). Each participant was asked to complete a maternal and paternal version of the subscales for the most important mother and father figures in their lives. If they indicated having no mother or father figure, participants were instructed to skip those respective subscales.

Parental psychological control (e.g., 'My mother/father brings up my past mistakes whenever she/he criticizes me') was measured using 8 items from the Psychological Control Scale – Youth Self-Report (Barber, 1996). Parental responsiveness (e.g., 'My mother/father can make me feel better when I am upset') was measured using 7 items from the Child Report of Parent Behavior Inventory (Schaefer, 1965; Schludermann & Schludermann, 1988). Parental autonomy support (e.g., 'My mother/father lets me choose what to do, whenever that is possible') was measured using 7 items from the Autonomy Support Scale of the Perceptions of Parents Scale (Grolnick et al., 1991).

Psychopathology

Psychopathology was assessed using the Dutch translation of the 53-item Brief Symptom Inventory (BSI-53), which has been validated for use in adolescent and adult populations (Derogatis & Melisaratos, 1983; Handal et al., 1993a; Piersma et al., 1994). The BSI-53 consists of nine subscales on specific past-week psychiatric symptomatology, including somatization, obsessiveness, insecurity in social contact, depressiveness, anxiety, aggression and hostility, phobic anxiety, paranoid thinking, and psychoticism symptoms, plus four additional items. Participants were presented with a list of problems of each of these subscales, and were then asked to indicate to what extent, if at all, they had been bothered by each problem throughout the past week (including the day of testing). All items were then scored ranging from '0 Not at all' to '4 Extremely'. The specific subscale scores were not used in the current study. Instead, as per the BSI-53 manual, a Global Severity Index (GSI) score was calculated by taking the mean across all items. As such, the GSI represents the general presence and severity of psychopathology symptoms, ranging from 0 to 4.

Psychopathology is relatively undifferentiated during adolescence (McGorry

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et al., 2018) – and this is also reflected in the high intercorrelations between psychopathology dimensions that we found in earlier factor analysis on psychopathology symptoms in the adolescents of this sample (Achterhof, Kirtley, Schneider, Hagemann, et al., 2021). In this study, we assess psychopathology levels from a broad spectrum of psychiatric complaints, as an indicator of general psychological distress. The GSI represents all items included in the BSI-53. Previous psychometric investigations of the BSI-53 in adolescents have suggested that it assesses a valid and primarily unidimensional construct of general psychological distress (Handal et al., 1993b; Piersma et al., 1994).

Experience Sampling

The following items from our daily ESM questionnaire were used to construct all relevant moment-level variables (note that the full ESM questionnaire is listed in the Supplemental Material): *'Who am I with?'* (non-mutually exclusive answer options: *'father'*, *'mother'*, *'other family (from nuclear family)'*, *'other family (outside of nuclear family)'*, *'friend(s)'*, *'other peers'*, *'teacher'*, *'other (familiar) people'*, *'unfamiliar people'*, *'no-one'*; if participants indicated to be in company, they were also presented with the following four social experience items *'I feel at ease in this company'*, *'I feel appreciated by this company'*, *'I feel like I belong'*, and *'I would rather be alone'* (answer options here ranged from *'1. Not at all'* to *'7. Very much'*).

Using the company information, a momentary *'company type'* variable was computed with answer options *'with mother'* (i.e., when in the company of mother but no one else), *'with father'* (i.e., when in the company of father but no one else), *'with non-family'* (i.e., when in the company of any [combination of] non-family members), and *'mixed social situations'* (i.e., all other social situations). Only the first three categories of this variable were used to assess the differential social experience when with different people, as we did not have any specific hypothesis for the *'mixed'* social situations.

Using this information, the variables *'proportion of social interactions with mother'* and *'proportion of social interactions with father'* were constructed by computing the per-person proportion of time spent with either mother or father across all completed ESM questionnaires. These variables indicate the time spent with mother and father per participant and are used as covariates in subsequent analysis.

As main outcome variable, a mean momentary *'social experience'* variable was computed, by taking the average of the four momentary social experience variables (whereby the item *'I would rather be alone'* was reversed). As registered prior to data analysis, we first assessed whether the internal consistency of these variables was sufficient (i.e., between-person Cronbach's alpha > .50) – and it was, at .75. This variable was also used to compute the three person-level means

of 'mean social experience when with mother', 'mean social experience when with father', and 'mean social experience when with non-family members' – all of which were used as variables in the comprehensive path model.

Statistical Analyses

The analyses for this study are twofold: First, we tested the specific associations between parenting styles and momentary social experiences using linear multilevel models – both overall, and for different types of company. Second, we explored the possible mediating effects of daily-life social experience in the relationship between parenting styles and general psychopathology a path analysis. In this path analysis, we did not consider the multilevel nature of the data, as – to the best of our knowledge – traditional multilevel mediation models do not allow for the testing of the multiple Level 2 → Level 1 → Level 2 paths that are included in the model (Preacher et al., 2010).

The major R packages that we used were tidyverse (v.1.3.0) (Wickham et al., 2019) for data manipulation, nlme (v. 3.1-150) (Pinheiro et al., 2021), and lavaan (v. 0.6-7) (Rosseel, 2012) for analyses, tidySEM (v. 0.1.8) (Van Lissa, 2021) and ggplot2 (v. 3.3.3) (Wickham, 2016) for visualizations, and knitr (v. 1.30) (Xie, 2021) for producing analysis reports.

Multilevel models predicting social experience from parenting styles

To test the effects of parenting style on overall social experience, a three-level linear analysis was conducted using the 'nlme'-package in R, with moments nested within participants, participants nested in schools, and with random intercepts but fixed slopes. In each model, the time-variant (i.e., moment-level) 'social experience' variable was predicted by the six time-invariant (i.e., person-level) parenting style variables. Also included in this analysis were the time-variant 'company' factor variable (without the 'mixed company' category), and the time-invariant covariates of age, gender, and the 'proportion of social interactions with mother' and 'proportion of social interactions with father' variables. Then, to test whether the effect of parental bonding on social experience is different for different types of company, the same multilevel model was tested whereby a number of interaction terms were added simultaneously. These terms included the interaction effects between age and each parenting style, between gender and each parenting style, and between company type and each parenting style. To identify the nature of possible interaction effects, we visualized the estimated social experience in different companies for different levels of the specific parenting style (i.e., -1/+1 standard deviation of the mean).

Exploratory comprehensive path model predicting psychopathology from both parenting styles and mean social experiences

For the path model, we estimated one comprehensive path model with all six parenting styles as predictors of the three mean social experience variables (i.e., when with mother, father, and non-family) and of psychopathology. Psychopathology was also separately predicted by the three mean social experience variables in this model. This path model is tested using the 'lavaan'-package in R.

Power Analysis

In the registration for this study, we described the power analysis that we would perform, following a strategy described by Lafit and colleagues (Lafit et al., 2020). Power was computed by performing the confirmatory analyses described above on 1000 Monte Carlo-based simulations, for a three-level model with 10 beeps per day for six days and an average compliance rate of 50%, aiming to achieve .80 power. For each of the 1000 simulated samples, the power is then estimated as the number of Monte Carlo replicates in which the null hypothesis is rejected.

Parameter estimates to construct the simulated data sets were based on similar data from an adolescent and young adult twin data set described elsewhere (i.e., TwinssCan) (Achterhof et al., 2020; Pries et al., 2019). Access to this data set only allowed us to test the power of the direct associations between parenting styles and mean daily-life social experience, as participants were not asked in the experience sampling whether they were with mothers/fathers specifically – thereby not allowing for the testing of our described interaction effects. Also, in this TwinssCan data set, all variables were defined differently than, as parenting styles were based on the Parental Bonding Instrument (Parker et al., 1979), and mean social experience was constructed using slightly different items. In addition, this power analysis did not include the third school level in the multilevel analysis, as participants were not clustered in schools in the TwinssCan data set as they were in the SIGMA data set.

The results of this power analysis revealed $>.99$ power for the positive associations between maternal/paternal responsiveness and mean social experience, and very low power (between .05 and .10) for the associations between the other parenting styles and mean social experience. Note, however, that these latter associations and its accompanying effect size estimates (between psychological control/autonomy support and social experience) had

been very weak and non-significant in the estimation of these parameters in the TwinssCan data set. Although power was therefore extremely low for these associations, we still decided to continue with the analyses as planned, as (1) the differentially constructed variables in the TwinssCan might have produced biased parameter estimates, and (2) interaction effects might still be significant, even though main effects are not. Full code for both the parameter estimates and for the power analysis can be found on the OSF-page for this project.

Open Science Practices

All hypotheses and analyses were registered following data collection, but prior to data access, i.e. a post-registration (Benning et al., 2019). When performing all analyses for this study, as planned in our registration (main registration available on OSF-page here: <https://bit.ly/3wH3LPE>; and the supplement that includes the exploratory mediation analysis here: <https://bit.ly/2R9Cvsu>), we encountered some inconsistencies across research questions, hypotheses and analysis plan, and some suboptimal analytic decisions. Therefore, we decided to change some details of the analysis, and report these deviations in full in the transparent-changes document (see supplemental material). Also, all code and output of the confirmatory, exploratory and sensitivity analyses have been uploaded to the OSF page for this study (<https://bit.ly/3x39NtZ>). All ESM items are publicly available in the ESM Item Repository (www.esmitemrepository.com) (Kirtley, Hiekkaranta, et al., 2020).

Results

Descriptive information of the sample is presented in Table 1. For $n = 114$ participants, no ESM data was available, and these were excluded from the current analyses, thus leaving an initial sample size of $n = 1799$. A more extensive description of this study and the sample's characteristics is included elsewhere (Kirtley et al., 2021).

Correlations between all parenting styles and the proportion of time spent with mother/father are presented in Table 2. The different parenting styles are moderately correlated with each other (between .21 and .71, and the parenting styles are only very weakly associated or not significantly associated with the proportion of time spent with mother or father (between .01 and .07).

Associations Between Parenting Styles and General Daily-Life Social Experiences

Our first research question referred to the prediction of mean daily-life social experience by parental autonomy support, psychological control, and responsiveness. Results pertaining to these hypotheses (Table 3) indicate how maternal responsiveness and paternal autonomy support are both significant positive predictors of more positively experienced social interactions in daily life; while maternal psychological control is a negative predictor of mean social experience.

While included as covariates (and thus not part of the confirmatory hypotheses), we note how the proportion of time spent with father (but not mother) is significantly and *negatively* associated with mean social experience. Also, compared to social interactions with non-family members, participants generally reported a more negative social experience when they interact with their father only, and a more positive social experience when interacting with their mother only.

Table 1: Descriptives of included variables

	Variable	Available n	Mean (SD)	Median	Range
Demographics	Age	1789	13.7 (1.8)	13.0	11.0-20.0
	Gender (%females)	1785	63.7		
	Number of completed beeps (out of 60)	1799	24.8 (12.7)	24.0	1.0-59.0
Psychopathology (BSI-53)	GSI	1452	0.9 (.6)	0.7	0.0 – 3.4
Social Behavior (ESM)	%in company	1799	86.4 (11.4)	91.3	0.0 – 100.0
	%time with mother only	1799	5.1 (2.1)	0.0	0.0 – 100.0
	%time with father only	1799	3.0 (1.7)	0.0	0.0 – 76.2
	%with non-family members	1799	46.8 (5.8)	45.8	0.0 – 100.0
Social experiences (ESM)	With mother only	874	6.0 (1.3)	6.5	1.0 – 7.0
	With father only	610	5.3 (1.8)	6.1	1.0 – 7.0
	With non-family members	1756	5.7 (1.0)	5.86	1.0 – 7.0
	Overall	1792	5.8 (1.0)	6.0	1.17 – 7.00
Maternal parenting styles	Autonomy support	1372	26.9 (4.9)	27.0	7.0 – 35.0
	Psychological control	1361	15.2 (5.9)	14.0	8.0 – 38.0
	Responsiveness	1393	30.6 (5.3)	32.0	7.0 – 35.0
Paternal parenting styles	Autonomy support	1411	25.7 (5.0)	26.0	7.0 – 35.0
	Psychological control	1385	15.8 (5.7)	15.0	8.0 - 40.0
	Responsiveness	1433	27.6 (6.9)	29.0	7.0 – 35.0

Table 2: Correlations between the six parenting styles and the covariate of time spent with mother/father.

	PPC	PR	MAS	MPC	MR	% with father only	% with mother only
PAS	-.54**	.71**	.45**	-.29**	.36**	.06*	-.07**
PPC		-.49**	-.21**	.52**	-.25**	-.03	.06*
PR			.27**	-.25**	.41**	.07**	-.05
MAS				-.52**	.67**	-.03	.01
MPC					-.52**	.02	.02
MR						-.01	.01
% with father only							.05*

* $p < .05$; ** $p < .01$

PAS = Paternal Autonomy Support; PPC = Paternal Psychological Control; PR = Paternal Responsiveness; MAS = Maternal Autonomy Support; MPC = Paternal Psychological Control; MR = Maternal Responsiveness

Table 3: Predicting momentary social experience from parenting styles, and from the cross-level interactions between parenting styles and company types

		Model 1 (no interaction effects)			Model 2 (with interaction effects)		
		<i>B (SE)</i>	<i>95% CI</i>	<i>p</i>	<i>B (SE)</i>	<i>95% CI</i>	<i>p</i>
Intercept		5.71 (.05)	5.61; 5.82	<.001	5.69 (.06)	5.58; 5.80	<.001
Covariates	Gender (female)	-.03 (.06)	-.14; .08	.62	-.03 (.06)	-.14; .07	.54
	Age	-.04 (.02)	-.07; -.00	.042	-.04 (.02)	-.08; -.01	.018
	%time with father	-1.30 (.43)	-2.14; -.46	.003	-1.36 (.43)	-2.20; -.52	.002
	%time with mother	-.45 (.32)	-1.09; .18	.16	-.39 (.32)	-1.03; .25	.23
	Father company*	-.15 (.04)	-.23; -.08	<.001	-.17 (.04)	-.25; -.09	<.001
	Mother company*	.43 (.03)	.37; .49	<.001	.42 (.03)	.36; .48	<.001
Parenting style predictors	MAS	.02 (.01)	-.00; .03	.059	.03 (.02)	-.00; .06	.10
	MPC	-.01 (.01)	-.03; -.01	.028	-.01 (.01)	-.04; .01	.34
	MR	.02 (.01)	.00; .03	.025	.01 (.01)	-.02; .03	.71
	PAS	.03 (.01)	.01; .05	.001	.03 (.02)	-.01; .06	.10
	PPC	-.01 (.01)	-.03; .00	.08	-.02 (.01)	-.05; .00	.07
	PR	.01 (.01)	-.00; .02	.06	.01 (.01)	-.01; .03	.38
Mother company x Parenting style interactions effects	Mother x MAS				.01 (.01)	-.01; .03	.21
	Mother x MPC				-.01 (.01)	-.03; .00	.06
	Mother x MR				.02 (.01)	.00; .04	.028
	Mother x PAS				-.03 (.01)	-.05; -.01	.004
	Mother x PPC				-.00 (.01)	-.02; .01	.58
Father company x Parenting style interaction effects	Mother x PR				.00 (.01)	-.01; .02	.69
	Father x MAS				-.00 (.01)	-.03; .03	.87
	Father x MPC				.02 (.01)	-.00; .04	.12
	Father x MR				-.01 (.01)	-.04; .01	.30
	Father x PAS				-.00 (.01)	-.03; .03	.93
Gender x Parenting style interaction effects	Father x PPC				-.04 (.01)	-.07; -.02	<.001
	Father x PR				.00 (.01)	-.02; .02	.67
	Gender x MAS				-.02 (.02)	-.05; .02	.39
	Gender x MPC				-.00 (.02)	-.03; .03	.96
	Gender x MR				.02 (.02)	-.01; .06	.16
Age x Parenting style interaction effects	Gender x PAS				.01 (.02)	-.03; .05	.67
	Gender x PPC				.02 (.02)	-.01; .05	.15
	Gender x PR				.00 (.01)	-.02; .03	.80
	Age x MAS				-.00 (.00)	-.01; .01	.95
	Age x MPC				.00 (.00)	-.01; .01	.66
Age x Parenting style interaction effects	Age x MR				-.01 (.00)	-.02; .00	.13
	Age x PAS				.00 (.00)	-.01; .01	.43
	Age x PPC				-.00 (.00)	-.01; .01	.85
	Age x PR				-.00 (.00)	-.01; .00	.19

*Within-person variable, compared to reference category: 'Non-family member company'
PAS = Paternal Autonomy Support; PPC = Paternal Psychological Control; PR = Paternal Responsiveness; MAS = Maternal Autonomy Support; MPC = Paternal Psychological Control; MR = Maternal Responsiveness; p-values in bold italics indicate $p < .05$; p-values in bold only indicate $p < .01$.

Associations between Parenting Styles and Social Experience in Different Companies

In Table 3, the results of the models including the cross-level interaction effects between parenting style and different types of company are also presented. First, no direct associations between parenting style and social experience remained significant when including these interaction terms. Results indicated some significant cross-level interaction effects: Between maternal responsiveness and being with mother vs. non-family (positive interaction); between paternal

autonomy support and being with mother vs. non-family (negative interaction); and between paternal psychological control and being with father vs. non-family (negative interaction).

The directions of these interaction effects are visualized in Figures 1-3. In Figure 1, we can see how participants with low or high levels of maternal responsiveness both report higher mean social experience quality when they are with their mother, compared to when they are with non-family members. This effect of higher social experience quality when with mother is slightly larger for those with higher levels of maternal responsiveness. Figure 2 illustrates how participants with low or high levels of paternal autonomy support have comparable estimated social experience quality when they are with their mother, and both groups report worse social experience quality when they are with non-family members. However, for those with lower levels of paternal autonomy support, social experience quality when with non-family members is lower (compared to those with higher paternal autonomy support levels). Finally, in Figure 3, we see how participants with higher levels of paternal psychological control had a higher estimated negative social experience quality when they were with their father compared to when with non-family members, while participants with low paternal psychological control levels seem to have comparable estimated social experience quality when they are with non-family members and when they are with their father.

Figure 1: The significant interaction effect between MR (Maternal Responsiveness) and maternal versus non-family company in the prediction of mean social experience, for participants ± 1 standard deviation of the Maternal Responsiveness mean (5.27).

Figure 2: The significant interaction effect between PAS (Paternal Autonomy Support) and maternal versus non-family company in the prediction of mean social experience, for participants $\pm$ 1 standard deviation of the Paternal Autonomy Support mean (4.95).

Figure 3: The significant interaction effect between PPC (Paternal Psychological Control) and paternal versus non-family company in the prediction of mean social experience, for participants $\pm$ 1 standard deviation of the Paternal Psychological Control mean (5.66).

Table 4: All standardized direct effects in the comprehensive, exploratory path model with parenting styles as six independent variables; three mediating variables of mean daily-life social experience; and one outcome variable of psychopathology.

Direct effects				
Outcome	Predictor	B(SE)	95% CI	p
GSI	Social experience - mother only	.05 (.04)	-.03; .12	.22
	Social experience - father only	.00 (.02)	-.04; .05	.90
	Social experience - non-family	-.26 (.04)	-.34; -.17	<.001
	PAS	.01 (.01)	-.01; .04	.30
	PPC	.02 (.01)	-.00; .04	.09
	PR	-.02 (.01)	-.04; .00	.07
	MAS	.00 (.01)	-.02; .03	.71
	MPC	.04 (.01)	.02; .06	<.001
	MR	.03 (.01)	.00; .05	.049
Social experience - mother only	PAS	.02 (.03)	-.03; .01	.41
	PPC	.02 (.02)	-.03; .01	.46
	PR	.02 (.02)	-.02; .06	.38
	MAS	.04 (.03)	-.02; .01	.16
	MPC	-.05 (.02)	-.09; -.01	.013
	MR	-.01 (.03)	-.06; .05	.82
Social experience - father only	PAS	.07 (.04)	-.02; .15	.13
	PPC	-.05 (.03)	-.11; .02	.17
	PR	.04 (.03)	-.02; .09	.25
	MAS	.01 (.04)	-.07; .09	.79
	MPC	-.01 (.03)	-.07; .05	.66
	MR	-.03 (.04)	-.11; .05	.45
Social experience - non-family	PAS	.07 (.02)	.02; .11	.003
	PPC	-.02 (.02)	-.05; .02	.29
	PR	-.00 (.02)	-.04; .03	.79
	MAS	.01 (.02)	-.03; .05	.69
	MPC	.00 (.02)	-.03; .03	.85
	MR	.03 (.02)	-.01; .07	.17

PAS = Paternal Autonomy Support; PPC = Paternal Psychological Control; PR = Paternal Responsiveness; MAS = Maternal Autonomy Support; MPC = Paternal Psychological Control; MR = Maternal Responsiveness; GSI = General Severity Index, or mean psychopathology. P-values in bold italics indicate $p < .05$; p-values in bold only indicate $p < .01$.

Path model

To test the corrected associations between social experience in different companies, parenting styles and general psychopathology, we tested a path model that included these variables. The results of this path model are presented in Table 4. Fit statistics indicate extremely good fit of this model versus the null model ($\chi^2 = 1016.82$, $p < .001$; CFI = $> .99$; TFI $> .99$), and extremely good absolute fit (RMSEA 90% CI = [$<.001$ - $<.001$]; $p < .001$; SRMR $< .001$). The statistically significant direct effects are visualized in Figure 4: Paternal autonomy support is a positive predictor of mean social experience when with non-family members; maternal psychological control is negatively associated with social experience when with mother only, and with general psychopathology levels; maternal responsiveness is positively associated with general psychopathology levels; and of the mediators, only mean social experience when with non-family members is negatively associated with general psychopathology levels.

Figure 4: Visualization of comprehensive path model, with only the significant direct associations between variables displayed. Figure was constructed using the 'tidySEM'-package (Van Lissa, 2021). GSI = General Severity Index, or mean psychopathology. * $p < .05$; ** $p < .01$; *** $p < .001$

Discussion

In this study, we found support for several of our hypotheses. We found support for maternal psychological control and responsiveness, and paternal autonomy support, specifically relating to the quality of adolescents' daily-life social interactions. When investigating the link between parenting styles and daily-life social experiences in different types of company, we saw a number of significant interaction effects: Maternal responsiveness and paternal psychological control were differentially associated with the experience of social interactions with parents. Paternal autonomy support was predictive of a more positive experience of social interactions with non-family members. This latter relationship was also significant in the comprehensive path model and was associated with psychopathology symptom levels. Moreover, this path model demonstrated how adolescents with generally more positive non-family (but not mother or father) interactions had lower levels of psychopathology symptoms.

The results of this study highlight the great relevance of altered social experiences – particularly with those outside the family – for understanding the impact of parenting styles on adolescents' (social) well-being. This study highlights the general and pervasive effects of maladaptive parenting styles, as parenting seems to broadly affect adolescents' interactions with parents and non-family members at the micro-level of everyday life. Moreover, the current study illustrates how this relationship could be relevant for the development of psychopathology, with a particular role for fathers and social experiences with those outside the family.

Parenting Styles and Daily-Life Social Experiences

The first aim of this study was to identify those parenting styles that are particularly relevant for adolescents' experience of daily social interactions. We found maternal psychological control, maternal responsiveness and paternal autonomy support to be of specific relevance for social experience quality. The unique effect of these three different parenting styles aligns with the theoretical conception of these parenting styles as distinct influences on adolescents' psychosocial development (Soenens et al., 2017).

Autonomy-supportive parenting arose as a particularly impactful factor, as it differentiated adolescents who experienced social interactions with non-family members as positive vs. negative. Parental autonomy support has been described as stimulating the volitional functioning of children by empathizing with children's point of view, allowing them to make decisions, and generally encouraging them to take initiative at their own pace (Grolnick et al., 1991; Soenens & Vansteenkiste, 2010). While the adaptive outcomes of parental autonomy support are largely

conceptualized as adjustment in terms of academic competencies, there is also evidence for autonomy support fostering children's social competence (Soenens & Vansteenkiste, 2005). In this study, we focused on the experienced quality of social interactions rather than the competencies to engage in social behaviors. However, it might be that social competence is a mediating factor here, as the reported positive social interactions with non-family members for those high in paternal autonomy support might be explained best by autonomy-support-driven increased social competence.

Of note is that, in previous work on a comparable sample of Flemish adolescents, *maternal* rather than *paternal* autonomy support was found to contribute mostly to social competence (Soenens & Vansteenkiste, 2005). As our sample was similar, the difference with our study – where we report a unique impact of paternal rather than maternal autonomy support – might reflect a change in mothers' and fathers' roles in the fifteen years between these studies. An increased unique relevance of fathers for children's development has been reported in other recent studies as well (Lansford et al., 2014). What these findings indicate is that fathers and mothers have unique, complementary roles. This notion has also been emphasized by attachment researchers (Bretherton, 2010; Y. L. Liu, 2008), as early attachment and parenting research has not sufficiently considered the distinct roles of mother vs. father.

Interaction effects revealed social effects of maternal responsiveness and paternal psychological control – however, these effects seemed mostly related to differential experiences of parent rather than non-family interactions. Parental responsiveness is defined in terms of emotional support provision and expressed affection (Davidov & Grusec, 2006), and as such, it is not entirely unexpected that adolescents with more perceived maternal responsiveness also experience interactions with their mother as more positive. However, while this effect of responsiveness on social experiences is stronger for interactions with mothers, it seemed that those with more responsive mothers also perceived their non-family interactions as more positive.

Psychological control is usually regarded as a particularly maladaptive parenting style (Barber, 1996; Barber & Harmon, 2004), and we found a significant direct effect of maternal psychological control on the mean quality of all social interactions. Also, interaction effects indicated that for those with high levels of psychological control, the quality of social experiences with their father were worse than interactions with non-family members. At the same time, high levels of psychological control did not seem associated with worse experiences of non-family interactions. This finding is in contrast to the expectation that psychological control might have a unique detrimental effect across different types of social interactions and might, as such, drive the development of psychopathology.

The Mediating Role of Social Experiences in Predicting Psychopathology

Although the mediation of the relationship between parenting styles and psychopathology by altered daily-life social experiences is implied in most theories of developmental psychopathology (Davies & Sturge-Apple, 2014), it has scarcely been explored at the level of daily life. The path model in this study, however, explicitly illustrates this tacit assumption, and suggests a potential mediating role for altered social experiences with non-family members specifically – as the only mean social experience variable that significantly predicted psychopathology levels was the variable representing the non-family member social experiences.

The particular relevance of non-family interactions is consistent with theories on adolescent social development, which emphasize a shift from parents to peers in the transition towards adulthood (Smetana & Rote, 2019). The current findings add to this theoretical notion by demonstrating how positive social experiences outside of the family actually represent an important correlate of psychopathology symptom development. This does not negate the value of good parent-child relationships, as we also see how social experiences outside the family might be partially shaped by experiences with parents – notably, by autonomy supportive parenting. However, the findings of this study emphasize a particular function of adaptive parenting, as it can prepare adolescents for interacting with people outside of the family with an increased sense of security. Although the current study precludes causality claims, in light of the larger developmental psychopathology body of evidence, it is exactly this greater sense of security that seems crucial for protecting against the development of psychiatric distress.

Strengths and Limitations

This study has several considerable strengths. First, we were able to draw on one of the largest experience-sampling datasets available, which allowed for reliable and ecologically valid estimates of the experiences of adolescents' social interactions. The manner in which social interactions were measured in this study is relatively unique, assessing adolescents' experiences of social interactions at the moment that they engage in them – rather than some time afterwards. Second, this study was registered before data access (but following data collection), and all code and analyses are available online. This contributes to transparency, reproducibility, and replicability efforts which are increasingly recognized as priorities in both clinical psychology and experience-sampling research (Kirtley, Lafit, et al., 2020; Tackett et al., 2017, 2019).

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Despite these strengths, the results of this study should be interpreted in light of its limitations. First, compliance to the experience sampling protocol was relatively low, compared to other experience sampling studies, which usually involve compliance levels between 70-80% (Rintala et al., 2020). This low compliance might also drive the relatively few endorsements of our outcome variable of social interactions with solely mother or father. One likely cause for the low compliance is the lack of incentivization in this study, as many ESM studies pay participants per completed questionnaire. We did not use compliance-contingent incentivization in this study, as we feared that this might increase careless responding. Still, additional research is required to test this assumption. Another potential cause for the low compliance is the relatively short response delay of 90 seconds to respond to each ESM questionnaire. While allowing for longer response delays might yield increased compliance, it also undermines one of the key strengths of ESM, that is, to measure as 'in the moment' as possible. Recent research suggests that longer response delays in ESM studies do in fact lead to qualitatively different responses (Eisele, Vachon, et al., 2021), thereby underscoring the importance of short response delays. Furthermore, the path model was based on cross-sectional data, and does not allow us to make inferences on the temporal ordering or causality of the investigated associations (Cole & Maxwell, 2003; Maxwell & Cole, 2007). It is highly likely that psychopathology levels also affect both perceptions of parenting and daily-life social experiences. In addition – as widely recognized by developmental psychologists – the parent-child relationship is bidirectional in nature, as parenting styles are also affected by children's behaviors (Patterson & Fisher, 2002; Smetana et al., 2006). Therefore, the path model presented here should be considered as exploratory and descriptive rather than confirmatory. Future work is needed to shed additional light on the sequence of events in the presented mediation model.

Implications and Future Directions

The results of this study speak to potentially impactful implications. Notably, while much previous research has focused on the importance of adaptive maternal parenting, these results emphasize how fathers play a unique role in the socialization and development of children and adolescents as well. Paternal autonomy supportive parenting distinctly related to the experience of day-to-day social interactions with non-family members, and through this association, also with psychopathology levels. If this finding proves robust following future replication, parenting intervention programs should ensure that they are inclusive of both fathers and mothers, and stimulate autonomy supportive parenting. Additionally, as the quality of interactions with non-family members appeared

uniquely associated with psychopathology symptoms, accurate assessment of social experiences in daily-life might provide a valuable focus for mental health prevention and treatment programs. This may take the form of, for example, ecological momentary interventions (EMIs) that aim to explicitly target daily-life processes for the treatment of early psychopathology (Myin-Germeys et al., 2016b; van Aubel et al., 2020).

Before being able to translate the current exploratory findings into concrete recommendations, however, several questions need to be answered. Primarily, as this study focused mainly on assessing general social experiences to predict general psychopathology, a further ‘unpacking’ of both these variables and of parenting styles and behaviors allows for the identification of more specific mediation processes in the relationship between parenting psychopathology. For example, autonomy supportive parenting is believed to instill a general sense of volitional functioning in children, making them more likely to approach peers, which in turn, might foster friendships and protect against the development of psychopathology (Soenens & Vansteenkiste, 2005). In addition, our study did not assess parenting behaviors with ESM, although an increasing number of studies have demonstrated the feasibility and usefulness of focusing on more micro-level parent-child processes (Janssen et al., 2020; Van Der Kaap-Deeder et al., 2016). Research that considers both predictors and outcomes at the level of daily life (e.g., from both child and parent) not only allows for examining these micro-level processes in more detail, but also allow for assessing individual variation in within-person or within-family processes (Hamaker, 2012). Future work could test micro-level hypotheses with increasing accuracy– thereby generating essential knowledge of the adaptive and maladaptive processes that play out in adolescents’ day-to-day interactions.

Chapter 7:

Adolescents' Real-Time Social and Affective Experiences of Online and Face-to-Face interactions

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Abstract

Much disagreement exists surrounding the relationship between digital communication and adolescent well-being. Micro-level insight into the direct effect of online interaction on affective experiences in daily life is crucial to advancing this discussion. In this registered study, we used experience sampling in 1705 general-population adolescents ($n = 43,226$ total observations) to examine different emotional and social experiences, at the moment they engage in online and face-to-face social interactions. Adolescents reported significantly less positive affect when alone compared to when interacting online ($B(SE) = -.15(.04)$, $p = .001$), but significantly more positive affect ($B(SE) = .12(.04)$, $p < .001$) and less negative affect ($B(SE) = -.12(.03)$, $p < .001$) and loneliness ($B(SE) = -.65(.05)$, $p < .001$) when interacting face-to-face compared to online. Exploratory moderator analyses do not support the hypothesis that those with more social support experience greater benefits from online interaction. This study uniquely highlights both the momentary affective benefits and potential disadvantages of online interaction, thereby bringing clarification and nuance to this highly contentious topic.

Introduction

In the modern day and age, we are constantly connected (Fowler & Christakis, 2011). Most people across the globe – and young people in particular – own smartphones (Anderson & Jiang, 2018; Taylor & Silver, 2019; Vanhaelewyn et al., 2020). As digital communication technologies have become increasingly integrated into our lives, voices have sprung up claiming their negative effects on teenagers' well-being (Haidt & Twenge, 2021; Twenge et al., 2020). This worry about teenagers is grounded in our knowledge about adolescent development. Adolescence is a period of strong social changes, where an increasing independence from parents is developed (Blakemore & Mills, 2014), and it is the age at which most mental health problems first arise (Kessler et al., 2005; Solmi et al., 2021). As such, it has been argued that social media and computer-mediated communication more generally (CMC; a general term for social interaction through technological means) may have a particularly negative impact on the social development and well-being of today's teens (Twenge et al., 2019). Potential negative effects of digital technology on well-being may also be present in adults, but adolescents may serve as a sort of 'canary in a coalmine', as such negative effects might be first observed in this age group (Dienlin & Johannes, 2020).

With increasing worries about the relationship between CMC and adolescent well-being, the body of research on this issue has also grown – although with limited consensus so far. Reviews and meta-analyses suggest mixed findings, with either small positive and negative associations, or no associations between CMC and well-being in adolescents (Best et al., 2014; Jensen et al., 2019; Odgers & Jensen, 2020b; Orben, 2020). This lack of consensus on the well-being effects of CMC is driven by a great theoretical and methodological heterogeneity in the studies assessing this relationship (Odgers & Jensen, 2020c; Orben & Przybylski, 2019a, 2019b). Different studies and meta-analyses have used varying, rather general definitions of both digital technology use (or social media use, screen time) and well-being, and these associations have often been assessed at different time scales (Dienlin & Johannes, 2020). Blanket statements about average screen time or average social media use impacting well-being have been considered too general, and as such, not very informative. To optimally inform policy and efforts to improve adolescent well-being, it is, however, critical to gain reliable knowledge about the contested relationship between CMC and adolescent well-being.

Consequently, the need exists to identify what specific aspects of CMC are linked to what specific outcomes of well-being. A helpful tool in this endeavor is an overarching model such as the Hierarchical CMC Taxonomy, recently proposed by Meier & Reinecke (2020). Within their taxonomy, different types of research on

the link between CMC and well-being can be classified. In this model, Meier and Reinecke distinguish, for example, between *technology-centered* approaches and *user-centered* approaches, where the former captures more objective aspects of the CMC (e.g., frequency of texts) and the latter more subjective aspects (e.g., perceptions of online interactions). In a review of 34 systematic reviews, Meier and Reinecke report how a majority of studies (69%) followed this technology-centered rather than user-centered approach; but also that, compared to technology-centered indicators of CMC, studies that used user-centered indicators of CMC resulted in effect sizes that were two to three times as large. This highlights how, in the accurate prediction of well-being outcomes, measuring observable online behaviors may be insufficient – assessing what they are used for is crucial as well.

Taking a user-centered approach does require to define what specific uses of CMC are then most related to well-being. One specific yet ubiquitous use is that of using CMC to directly communicate with others. Evidence suggests that using CMC for interaction is more related to well-being than using it for non-interactive purposes (Best et al., 2014; Vandoninck et al., 2012). Moreover, relationships between CMC and well-being are expected to be strongest when looking at short-term effects rather than long-term effects, and focused on *affective* rather than *eudaimonic* well-being (Dienlin & Johannes, 2020). Affective (or hedonic) well-being is herein defined as pleasurable experiences, whereas eudaimonic well-being relates more to feelings of meaning and value (Huta, 2016). Using CMC for more interactive purposes should relate positively to short-term affective well-being in adolescents – although it is unclear how short this ‘short term’ actually is.

In addressing this question, most studies so far have been limited, as they have largely drawn on general self-report measures of CMC and general self-report measures of well-being. Such measures are, however, flawed, as they produce biased estimates of time spent on social media or the internet (Scharkow, 2016; Verbeij et al., 2021). Another limitation of previous work is that it is limited in its ability to speak to the short-term or immediate effects of digital communication. To address these issues, the Experience Sampling Methodology (ESM; Csikszentmihalyi & Larson, 1987; Myin-Germeys et al., 2018), also referred to as Ecological Momentary Assessment (EMA; Shiffman et al., 2008) has been put forward to examine the relationship between CMC and well-being (Dienlin & Johannes, 2020; Orben, 2020). ESM is an intensive longitudinal diary method, that can be used to examine the relationship between CMC and well-being at a momentary day-to-day level and assess how CMC in its naturalistic context relates to well-being around the time that it occurs (as in Berry et al., 2018; Beyens et al., 2020; Jensen et al., 2019; Johannes et al., 2019; Kross et al., 2013; Verduyn et al., 2015).

Researchers using ESM to study the associations between CMC and well-being in both adolescent and adult samples have already focused on differential effects of non-interactive vs. interactive digital technology use (Clark et al., 2018). Passive social media use, such as scrolling on Facebook, seems to be negatively associated with momentary (affective) well-being (Aalbers et al., 2019; Verduyn et al., 2017). Conversely, evidence suggests that more (inter)active use of digital technology is positively related to momentary well-being (Bayer et al., 2018; Lieberman & Schroeder, 2020; Liu et al., 2019; Orben, 2020). This potential beneficial relationship between online (interactive) behaviors and momentary well-being has been explained by increased feelings of connectedness (Best et al., 2014; Spies Shapiro & Margolin, 2014; Valkenburg & Peter, 2009).

Many ESM studies, however, have not yet turned to questions about the *immediate* affective benefits that CMC may have. Most studies have asked participants to report on their online activity either once at the end of a day (Gross, 2004; Jensen et al., 2019; Orben & Przybylski, 2019a), multiple times daily since the previous momentary questionnaire (Reissmann et al., 2018), or within a preceding time period (Hall, 2017). To our knowledge, almost no studies have explicitly questioned participants about their online behavior at the time that it occurs (an exception is a study by (Bayer et al., 2018) on $n = 154$ undergraduate students' Facebook use). Such a momentary focus would, however, be required to enable the assessment of the direct affective benefits or disadvantages of digital communication.

The investigation of short-term relationships between CMC and well-being may seem trivial, but we would argue that it is crucial for developing reliable knowledge within the entire taxonomy of CMC effects. Akin to Dienlin & Johannes (2020), other recent theoretical models of digital well-being have also described the need to focus on more specific online behaviors, and how they relate to well-being outcomes (Büchi, 2021; vanden Abeele, 2020). In these models, more micro-level effects of digital behaviors, when repeated, are assumed to contribute to longer-term well-being. This is similar to dynamic systems models that describe how long-term development is shaped by processes playing out at different levels and timescales (Kunnen et al., 2019; Smith & Thelen, 2003; van Geert & Lichtwarck-Aschoff, 2005). In addition to potential affective benefits of online communication, there is increasing evidence that when adolescents interact online, this may strengthen their social resources, which in turn can lead to increased well-being in the longer term (Domahidi, 2018). At the same time, however, the developers of these digital well-being models have acknowledged that relatively little specific knowledge exists about these initial, micro-level associations. To provide building blocks for future work on potential long-term effects of different types of digital behaviors, we first need to gain reliable knowledge on specific, immediate, and micro-level effects from a user-centered

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approach.

Therefore, in the current study, we take a user-centered approach and use ESM to learn more about the relationship between using CMC for interactive purposes and *immediate* affective and social well-being. Previous ESM work has revealed how positive affect (PA) and negative affect (NA) are distinct factors, each representing unique indicators of affective well-being (Eisele, Lafit, et al., 2021). Given previous positive relationships between interactive CMC and affective well-being, we consequently hypothesize that **"online social interaction is related to higher levels of momentary affective well-being (i.e., higher PA, lower NA) in adolescents, compared to being alone" (H1)**. Because ESM allows us to compare different moments, we need to compare the situation of online interaction to a situation where they do interacting online. In H1, it is compared to being alone, as we hypothesize that, in this comparison, online interaction produces benefits.

This is, however, not the only relevant comparison. Going online to communicate may be beneficial compared to being alone, but not necessarily when compared to interacting 'in real life' (Lieberman & Schroeder, 2020; Pea et al., 2012). Popular belief dictates that face-to-face interactions relate to more positive social outcomes compared to digital social interactions – although, again, this has not been systematically assessed at the moment of interaction. As the momentary effects of online social interaction may be different for emotional vs. social/connectedness outcomes (Bayer et al., 2018; Orben, 2020), it is useful to separate social from affective effects. Within ESM studies, momentary social qualities are often assessed as feeling belongingness and at ease within a specific social company, and as such, have been linked to mean psychopathology levels in adolescents (more so than the quantity of social interactions, see Achterhof et al., 2021). To assess the immediate affective and social quality correlates of online interaction versus face-to-face interaction, we hypothesize that **"compared to face-to-face interactions, online interactions are associated with lower levels of both (a) affective well-being (i.e., lower PA and higher NA), and (b) social quality." (H2)**

In addition, some empirical support exists for the idea that when people go online to communicate with others *while they are also with face-to-face company* (i.e., when there is a sort of 'double' social interaction happening), this may undermine connectedness to the face-to-face company (Brown et al., 2016; Dwyer et al., 2018; Kushlev & Heintzelman, 2014). What is unclear, however, is whether such potential negative effects of double social interactions apply only to the social experience of the face-to-face company, or also to the experience of one's online company. Reliable knowledge about such a potential short-term deleterious effect would teach us what specific behaviors may be maladaptive in the short term and might reasonably contribute to longer-term

effects on well-being (cf. Büchi, 2021). Therefore, we also aim to explore whether **"there is a general within-person difference in (a) affect, and (b) social interaction quality when 'double interacting' (i.e., interacting both online AND face-to-face), compared to when only interacting face-to-face, or only interacting online" (H3).**

Finally, the most common conclusion of a review of reviews was that effects of CMC on well-being depend on *moderating factors* (Meier & Reinecke, 2020). Much of the extant research on the relationship between CMC and well-being suggests uniformity of digital communication effects across adolescents, while the benefits or harms derived from digital communication likely differ for different people (Spies Shapiro & Margolin, 2014). Knowing who benefits from online interaction (and who does not) is extremely relevant when deciding where to potentially intervene.

One particularly relevant moderator is that of offline *social resources* – which has opposing hypotheses attached to it. The 'rich-get-richer' hypothesis suggests that internet use predicts better (social) well-being outcomes for those with more social resources (Kraut et al., 2002). This hypothesis implies that people who already have more social resources 'in the real world' benefit most from internet use, as it provides them with more opportunities to connect with an existing strong social network. In contrast, the 'social compensation' (or 'poor-get-richer') hypothesis posits that people with fewer social resources may generally be more comfortable interacting online than face-to-face, and will therefore benefit most from digital communication (McKenna et al., 2002).

However, within the context of these competing hypotheses, it is unclear what it means to be socially 'rich', as 'social resources' have been defined differently across studies. Previous definitions have focused on both internal states (such as extraversion, social anxiety, or loneliness) (Kraut et al., 2002; McKenna et al., 2002), but also on external factors (such as the quality of friendships or social support) (Kraut et al., 2002; Selfhout et al., 2009). Therefore, we will use different conceptualizations of social resources in our moderator analyses: social support, social skills, the mean quantity of daily-life face-to-face interactions, and the mean quality of daily-life face-to-face interactions. As such, we state our final exploratory hypotheses: **"The within-person relationship in H1 is moderated by (a) the quantity of face-to-face interactions, (b) the mean quality of face-to-face interactions, (c) social support, and/or (d) interpersonal skills" (H4); and "The within-person relationships in H2 is moderated by (a) the quantity of face-to-face interactions, (b) the mean quality of face-to-face interactions, (c) social support, and/or (d) interpersonal skills." (H5)**

In sum, in this high-powered, registered study, we aim to test the experience of online interaction – as it is happening in the moment. To do this, we will use ESM

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to assess the affective/social quality differences between situations of online interaction vs. situations of non-interaction; and between online interaction vs. face-to-face interaction. Additionally, we will explore the momentary effects of simultaneously interacting online and face-to-face, as compared to singularly interacting online or face-to-face. Finally, we will test whether these within-person differences are moderated by social resources, and if so, in which direction – thereby testing the competing ‘rich-get-richer’ vs. ‘social compensation’ hypotheses. Since it is not clear what it means to be socially ‘rich’, we will investigate a number of moderating social resources: interpersonal skills, social support, the mean quality of daily face-to-face interactions, and the frequency of daily face-to-face interactions.

Method

Participants

Between January 2018 and June 2019, a sample of $N = 1913$ adolescents was recruited as part of Wave 1 of the SIGMA study – a study aimed at elucidating the daily-life social and psychological processes associated with the development of psychopathology in adolescence (Kirtley et al., 2021). The full SIGMA study was approved by the local ethical committee (Ethics Committee Research UZ / KU Leuven S61395). A random sample of $n = 100$ participants was selected for the power analysis for the current study (see Power Analysis section below), and another 108 participants did not complete any ESM questionnaire. These participants were subsequently not included, thereby leaving a total sample of $n = 1705$ participants for the current analyses. For an overview of demographic information for this sample, see Table 1.

Participants within 22 cooperating secondary schools in the Flanders region of Belgium were informed about the study and invited to participate. When recruiting schools, we aimed to achieve diversity and representativeness in terms of geography, urbanicity, gender distribution, non-Belgian cultural backgrounds, and school levels – and we largely succeeded in this aim (Kirtley et al., 2021). Participants were recruited from each of the five provinces in Flanders, and from both rural and urban areas. The SIGMA study has an accelerated longitudinal design (Galbraith et al., 2017), in which data from three cohorts of participants are collected within the same wave. In the sample, there is a deliberate overrepresentation of first-year students, as the main interest of the study was to investigate the developmental changes from early adolescence onwards. Apart from the ability to read and understand Dutch and understand the study’s instructions, there were no specific inclusion criteria.

Procedure

Following an in-class information session, all participants and at least one parent or caregiver (for participants under 18) gave informed consent. Subsequently, participants completed a number of questionnaires that included the moderator variables for the present study (Kirtley et al., 2021) during an in-class testing session. At the end of the session, participants were instructed about the second part of the study involving the Experience Sampling Method (Csikszentmihalyi & Larson, 1987; Myin-Germeys et al., 2018). Each participant received a Motorola Moto E4 smartphone with the mobileQ application for ESM data collection (Meers et al., 2020). Participants were unable to access any settings/option on the smartphone (hereafter 'study device') other than the mobileQ application. Participants were instructed that for the next 6 days, they would receive ten prompts daily, at semi-random times between 7.30 AM and 10.30 PM. Prompts were distributed in blocks of 90 minutes with a minimum time window of 15 minutes between each consecutive prompt. As such, prompts were not too close together and roughly distributed throughout the day.

After prompts were sent out via the mobileQ app, participants had 90 seconds to respond to each prompt – after this period, the questionnaire would disappear. Once the questionnaire was opened, participants again had 90 seconds to respond to each item – if they took longer for any item, the questionnaire would disappear. In the app, participants were able to modify whether they wanted the notifications to appear with a beeping sound, a vibration, or both a sound and vibration (they were unable to put the phone on 'silent' without turning off the phone completely). In order to minimize disruption from notifications during school hours, an equal random notification schedule for all participants within the same class room was set. Participants were asked to keep the study device with them and to answer as many prompts as possible, without endangering or overly disrupting their daily lives. Finally, researchers and participants went through the entire ESM questionnaire together, in order to clarify the meaning of each ESM item. For all ESM items used in this study, participants were instructed to answer items as referring to the *moment right before the study device notified them*. For example, participants were instructed that if they were annoyed by the ESM prompt, this should not affect their response to the item 'I feel irritated' (instead their irritation level should reflect the situation right before the prompt).

The incentive for participation was a 10-euro gift voucher. ESM compliance-based incentives were not used. Due to the large size of the study, and due to the fact that all data were stored locally and only uploaded after the measurement period, we were unable to personally contact or monitor participants during the ESM period. Participants could contact the researchers via e-mail or phone if they encountered any issues throughout the ESM period.

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Measures

Experience Sampling Method

The full ESM questionnaire that participants received at every random prompt had a minimum of 41 and a maximum of 46 items. Survey length varied according to answers to conditionally branched items. See full ESM list on the OSF-page for this project (<https://bit.ly/33dYEc2>; also publicly available within the ESM Item Repository; Kirtley et al., 2020). Mean questionnaire completion time was 162.8 seconds. The total number of completed reports was 43.226; average compliance (defined as the mean proportion of prompts that were completed) for those participants who completed at least 1 ESM questionnaire was 42.3%. Although many previous ESM studies have set a minimum compliance rate for inclusion within their study, recent evidence suggests that this is not best practice, as potentially valuable data is omitted (Jacobson, 2020). Therefore, all complete ESM questionnaires were retained for the current study.

Independent Variable – Interaction Type.

A momentary variable 'Interaction Type' was constructed based on three different ESM items: 'Face-to-face company' (i.e., 'Who am I with?', with ten non-mutually-exclusive possible answer options, of which nine are different types of company [e.g., 'Friend(s)'], and one is 'No one', to signify being alone); 'Face-to-face interaction' (follow-up question when people indicated to be in company of others 'We are doing something together', rated from 1 'Not at all' to 7 'Very much', where a score of 1 was considered no face-to-face interaction and a 2 or higher as a face-to-face interaction); and 'Online interaction' (i.e., 'I am virtually in contact with others', rated as 'Yes' or 'No').

The variable Interaction Type represented four situations relevant for the current analyses:

- 'No interaction' (reporting neither online nor face-to-face interaction);
- 'Online interaction only' (reporting no face-to-face company or interaction, but reporting online interaction);
- 'Face-to-face interaction only' (reporting face-to-face interaction, but no online interaction);
- 'Double interaction' (reporting both face-to-face interaction and online interaction);

Dependent Variables – Positive and Negative Affect.

With each ESM prompt, participants were first presented with a number of affective items, phrased as 'I feel ...' and rated from 1 'Not at all' to 7 'Very much'.

From these variables, two outcome variables were constructed: Positive Affect (or PA; mean on items 'I feel cheerful', 'I feel satisfied', 'I feel relaxed'), and Negative Affect (or NA; mean on items 'I feel irritated', 'I feel anxious', 'I feel insecure', and 'I feel sad'. Within-person reliability was $\omega_{\text{within}} = .65$ for PA, and $\omega_{\text{within}} = .66$ for NA; between-person reliability was $\omega_{\text{between}} = .92$ for PA, and $\omega_{\text{between}} = .90$ for NA. In addition to these PA and NA variables, responses to the item 'I feel lonely' were considered as a separate outcome variable of momentary loneliness.

Dependent Variable – Social Quality.

When participants indicated being with any company, they were presented with three items inquiring about the quality of that current company: 'I feel at ease in this company', 'I feel appreciated by this company', and 'I feel like I belong', all rated on a scale from 1 'Not at all' to 7 'Very much'. Within-person reliability of these three items was $\omega_{\text{within}} = .86$, and $\omega_{\text{between}} = .92$. Analogous items were presented when participants indicated being in online company: 'I feel at ease with the people that I am in virtual contact with', 'I feel appreciated by the people that I am in virtual contact with', and 'I feel like I belong with the people that I am in virtual contact with'. Reliability for these three items was $\omega_{\text{within}} = .84$, and $\omega_{\text{between}} = .92$.

For each person, a 'Mean Social Quality (Face-to-Face)' variable, and a 'Mean Social Quality (Online)' variable was constructed, by taking the mean score on the three items inquiring about the quality of face-to-face and online company, respectively. For the analyses where online vs. face-to-face social quality scores are compared against each other within each person, these two variables were first combined into one variable 'Mean Social Quality (Online or Face-to-Face)'.

Moderator Variable – Mean Social Quantity.

Based on the 'Face-to-Face Company' variable described above, a person-level 'Mean Social Quantity' variable was constructed. This variable refers to the quantity or proportion of face-to-face interactions in the ESM week, and was calculated by taking the proportion of time across all completed ESM prompts that any individual indicated being in the company of others.

Moderator Variable – Mean Social Quality.

In order to get a person-level variable of the mean quality of face-to-face interaction, the mean score on the Mean Social Quality (Face-to-Face) variable was computed across all completed ESM prompts for that person.

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Retrospective Questionnaires

Moderator Variable – Interpersonal Skills.

An Interpersonal Skills score was calculated by taking the mean score on all 18 items of the 'Interpersonal Skills' subscale of the 'Vragenlijst Psychosociale Vaardigheden' (Scholte & Van der Ploeg, 2013). This subscale consists of the two subscales Relational Skills (e.g., 'I can get along well with different types of people'), and Affective Skills (e.g., 'I recognize in others how they feel or what they think'). All items were rated 1 'Completely disagree' to 5 'Completely agree'. The VPV also has two subscales on Self Guidance (e.g., 'I always do my best in school or at work') and Self Awareness (e.g., 'I think before I act'), together compiling an 18-item subscale of 'Intrapersonal Skills'. However, as these subscales largely target skills that are outside of what we consider 'social resources', these subscales were not used for the current study.

Moderator Variable – Social Support.

A social support score is calculated by taking the mean score on all 12 items of the Social Support List-Interactions (SSL-I-12; van Donderen, 2012). The SSL-I-12 consists of three subscales: Daily support (e.g., 'How often does it happen that people show interest in you?'); Support with problems (e.g., 'How often does it happen that people give you good advice?'); and Appreciation (e.g., 'How often does it happen that people compliment you?'), and all items were scored from 1 'Rarely or never' to 4 'Very often'. Per the instruction manual, a maximum of four items were allowed to be missing for calculating the total score.

Power Analysis

For the current research questions, power was calculated for the confirmatory hypotheses pertaining to the difference in affect between being in online interaction vs. being alone, and for online interaction vs. face-to-face interaction (i.e., H1 and H2). Given the unique nature of the current study, we had no indication of either the distribution of this variable, nor of its estimated effect size on affect. Therefore, we took a two-step approach for calculating the power (Lafit et al., 2020), and registered this as such before looking at the data.

First, a $n = 100$ random subsample of participants from the full data set (= roughly the sample size of most previous ESM studies into the relationship between online behavior and well-being) was requested from the local data manager of the SIGMA study. Six participants of this $n = 100$ had no ESM data and were subsequently excluded. In order to obtain estimates of the necessary effect sizes and model parameters, the confirmatory mixed effects analysis as outlined below was then conducted on this $n = 94$ sample.

Second, the model parameters and effect sizes of this analysis were used as input for 1000 Monte Carlo simulations of the data, with a sample size equal to the remainder of the data set ($n = 1813$). Of these simulations, the proportion of simulations where the null hypothesis – the effect size of interest being significantly different from zero – was rejected at $p < .05$ was taken as the power. As specified in the registration, we considered power exceeding .80 to be sufficient. However, since our estimates of the effect size were based on a subsample of 94 participants, we also accounted for the uncertainty around the parameters' estimates by performing sensitivity analysis and estimating power for the values in the upper and lower bound of the 95% confidence intervals of the estimated effects. The results of these simulation-based power analyses yielded power values of $> .95$ for all effects of interest, indicating sufficient power for our confirmatory hypotheses. R Markdown scripts detailing this power analysis can be found on the OSF-page for this study (<https://bit.ly/33dYEc2>).

Statistical Analysis

Confirmatory Analyses

For the confirmatory analyses pertaining to within-person differences between different types of online/face-to-face interaction vs. being alone (H1 and H2), mixed effects models with random intercepts were specified. Within these models, the time-varying categorical variable of 'Interaction Type' was a predictor at the momentary level, and the time-varying continuous affect variables were the momentary level outcomes (one model with PA as outcome; one with NA as outcome; one with loneliness as outcome). To assess the differential social qualities of online vs. face-to-face social interactions, a similar, separate analysis was specified with 'Mean Social Quality (Online or Face-to-Face)' as the outcome variable. For all analyses, the R package 'nlme' was used (Pinheiro et al., 2021).

The multilevel structure of the data means ESM prompts are nested within participants, nested within schools. However, since models did not converge when the school level was included, we followed our registered contingency plan for non-convergence and omitted the school level from further analyses. Convergence issues in multilevel models arise when the structure of the variance components is too complex relative to the sample size (see Bates et al., 2015; Eager & Roy, 2017), or by scaling issues (see, e.g., Clark, 2020). The errors were assumed to be Gaussian distributed and serially correlated. The serial correlation was modeled using an AR(1) process. Also, following non-convergence, different optimizers from the 'lmeControl' -function of the 'lmerTest' -package (Kuznetsova et al., 2017) were chosen for these analyses (as had been specified in the

registration). As also specified in the registration, the fixed effects pertaining to the H1 and H2 were tested with two-tailed Wald tests, applying Holm's multiple comparisons correction (Holm, 1979), with an initial $\alpha = .05$, for deciding on the significance of results.

Exploratory Analyses

For the exploratory analyses focusing on situations where people indicate to be simultaneously interacting face-to-face and online (i.e., H3), additional analyses were performed. In these analyses, either 'Mean Social Quality (Face-to-Face)' was the dependent variable (in the comparison with situations where people are interacting face-to-face only) or 'Mean Social Quality (Online)' was the dependent variable (in the comparison with situations where people are interacting online only).

Open Science Practices

All analyses of the current study were registered on the Open Science Framework (OSF) post-data collection using the template for registration of ESM studies (Kirtley, Lafit, et al., 2020). Registration happened post-data collection, but prior to data access (<https://bit.ly/3vbLTuM>), in line with what has been referred to as postregistration (Benning et al., 2019). All relevant code and materials have been made available online on the OSF-project for this study <https://bit.ly/33dYEc2> (ESM items are also publicly available in the ESM Item Repository; (Kirtley, Hiekkaranta, et al., 2020). Moreover, we aimed to adhere as much as possible to reporting guidelines for ESM studies with adolescents (van Roekel et al., 2019).

Deviation from Registration: Moderator Analysis

In the registration for this study, we originally intended to perform a multiverse analysis (Simonsohn et al., 2020; Steegen et al., 2016) for our moderator analyses (i.e., H4 and H5), to explore all possible equally justifiable combinations of covariates, analytic decisions and moderators. However, we later reconsidered this decision, based on arguments from a manuscript that was released following our registration (Del Giudice & Gangestad, 2021). The authors of this overview paper argued how multiverse analysis is inappropriate when, in fact, the different specifications that are selected are not all arbitrary and equally justifiable. First, including multiple indicators of a similar construct (i.e., social resources) in the same analysis is suboptimal, as these indicators will all remove relevant variance of each other. Instead, it would be better to run each analysis separately per

individual moderator variable. Second, including covariate variables in some tests but not in others means that these different tests will be not statistically equivalent to each other – and this is why this is discouraged. If one believes that all covariates are potentially uniquely relevant, then including all covariates is always the best solution. For our moderator analysis, this meant that we ended up with twelve justifiable combinations of analyses (for each of four moderators, and for each of three outcome variables). As this number is too limited for a multiverse analysis, we therefore decided to instead only perform the twelve most comprehensive analyses.

These comprehensive models are mixed-effects models predicting each of three affect variables from the four moderator variables directly, and from the cross-level interaction effects of each moderator variable with the social interaction variable. The four moderating variables are deliberately not simultaneously entered in the models, as doing so would unnecessarily reduce the explained variance of each moderator (Del Giudice & Gangestad, 2021). These analyses were conducted by adding the cross-level moderators of social support, interpersonal skills, quantity of face-to-face social interactions, and mean quality of face-to-face interactions to each of the mixed-effects models described in the previous section. Age and gender were also added as predictors of both the mean level of affect/loneliness, and as moderators of the relationship between interaction type and affect. We originally intended to include an AR(1) correlation structure as well, but since the models did not converge with this included, it was omitted from these moderator analyses. The interpretation of results of this moderator analysis will be done similarly to what was initially planned for the multiverse analysis, where the general pattern of effect sizes and p-values for the selected set of plausibly justifiable analytic decisions is explored.

Results

Descriptive statistics

Descriptive statistics of all included variables are presented in Table 1. Because missingness varied for different variables, the available sample size for every variable is also presented in Table 1. Of particular note is that, for each category of this variable, there are participants who did not endorse this category at any time during the ESM period. Notably, only 776 participants indicated being 'Online only' – the main category of interest, representing the situation where participants indicated being physically alone and interacting online – at least once during the ESM period. In a further investigation of potential differences between responders and non-responders to this category, we observed that the $n = 776$ participants who had responded 'Online only' at least once in the

ESM week were, on average, older ($t(df)=-10.13(1560.9), p<.001$), more likely to be girls ($\chi(df)=24.8(1), p<.001$), and had completed more ESM questionnaires ($t(df)=7.19(1689.4), p<.001$) than the $n = 929$ participants who had never responded 'Online only'.

Table 1: Descriptive information for the $n = 1705$ adolescents included in the current study.

	Variable	Available N	Mean (SD)	Median	Range
Demographic and background information	Age	1700	13.7 (1.8)	13.0	11.0 – 20.0
	Gender (%girls) ¹	1702	63.3		
	% in school year 1	1705	56.7		
	% in school year 3	1705	21.9		
	% in school year 5	1705	21.4		
	Non-Belgian geographic identification (%)	1276	35.7		
Moderator variables	Mean social quantity (ESM)	1705	86.7 (15.0)	91.7	0.0 – 100.0
	Mean social quality (ESM)	1693 ²	5.8 (1.0)	6.0	1.0 – 7.0
	Interpersonal skills (VPV)	1327	69.8 (7.7)	70.0	18.0 – 90.0
	Social support (SS-L-I)	1598	23.0 (6.1)	23.0	0.0 – 36.0
Interaction type (as % of all compliant beeps)	Online interaction only	1698	4.9		
	No interaction	1698	9.0		
	FtF interaction only	1698	54.6		
	Double interaction	1698	17.3		
ESM-level variables	Positive affect	1705	5.0 (1.0)	5.1	1.0 – 7.0
	Negative affect	1704	2.0 (0.9)	1.7	1.0 – 7.0
	Loneliness	1702	1.7 (0.9)	1.4	1.0 – 7.0
	FtF interaction quality	1693	5.8 (1.0)	6.0	1.0 – 7.0
	Online interaction quality	1472	5.8 (1.2)	6.1	1.0 – 7.0

5 participants expressed their gender identity as neither male nor female

FtF= Face-to-Face

Note that the available n for 'mean social quantity' can be different from that for 'mean social quality', as participants were only presented with the social quality items after indicating to be in other people's company – these 12 participants thus indicated no company for any completed ESM questionnaire.

Confirmatory analyses

Being alone vs. interacting online (H1)

Participants reported significantly less PA when they were alone compared to when they were in online interaction only. We found no evidence for a significant difference in either NA or loneliness between being alone and interacting online. The results pertaining to the first research question are displayed in Table 2, and visualized in Figure 1.

Adolescents' Real-Time Social and Affective Experiences of Online and Face-to-Face Interactions

Figure 1: Estimated affect levels for A) positive affect, B) negative affect, and C) loneliness, and 95% confidence intervals when in different types of interaction/company.

Table 2: Multilevel linear regressions, predicting momentary affect from the momentary interaction type variable. *P*-values are adjusted following Holm's multiple comparison correction, for an initial alpha of .05.

	Mean PA				Mean NA				Loneliness						
	<i>B (SE)</i>	<i>CI LL</i>	<i>CI UL</i>	<i>p</i>	<i>Adj. p</i>	<i>B (SE)</i>	<i>CI LL</i>	<i>CI UL</i>	<i>p</i>	<i>Adj. p</i>	<i>B (SE)</i>	<i>CI LL</i>	<i>CI UL</i>	<i>p</i>	<i>Adj. p</i>
<i>Reference category: 'Online only'</i>															
No interaction	-.15 (.04)	-.23	-.06	.001	.004	.01 (.04)	-.06	.08	.78	>.99	-.01 (.05)	-.12	.11	.90	>.99
FtF only	.12 (.04)	.05	.20	.001	.004	-.12 (.03)	-.18	-.06	<.001	<.001	-.65 (.05)	-.75	-.55	<.001	<.001
Double interaction	.27 (.04)	.19	.34	<.001	<.001	0.03 (.03)	-.10	.03	.35	>.99	-.49 (.05)	-.60	-.38	<.001	<.001
<i>Reference category: 'FtF only'</i>															
Double interaction	.14 (.02)	.10	.19	<.001	<.001	.09 (.02)	.05	.13	<.001	<.001	.16 (.02)	.12	.21	<.001	<.001
Random Effects															
AR(1)			.22					.22					.14		
ICC			.72					.77					.88		

FtF= Face-to-Face; *CI LL* = Lower limit of the 95% confidence interval around the *B* coefficient; *CI UL* = Upper limit of the 95% confidence interval around the *B* coefficient

Table 3: Results of twelve multilevel linear regressions, predicting momentary affect (PA, NA, loneliness) from momentary interaction type, with age and gender as covariates predicting both random intercepts and random errors, and four social resource variables also predicting random intercepts and errors. For each analysis, the reference category for the InteractionType variable is 'Online interaction only'.

Predictors	Mean PA					Mean NA					Loneliness				
	Estimates (SE)	LL	UL	p		Estimates (SE)	LL	UL	p		Estimates (SE)	LL	UL	p	
Main effect															
Social support	.05 (.01)	.03	.06	<.001		-.02 (.01)	-.03	-.01	<.001		-.02 (.01)	-.03	.00	.08	
Interaction effects:															
InteractionType*Social Support															
No interaction	-.02 (.01)	-.03	-.00	.029		.01 (.01)	-.00	.02	.23		.01 (.01)	-.01	.02	.60	
FtF only	-.01 (.01)	-.02	.01	.29		.00 (.01)	-.01	.01	.52		-.01 (.01)	-.02	.01	.38	
Main effect															
Interpersonal skills	.03 (.01)	.02	.05	<.001		-.03 (.00)	-.04	-.02	<.001		-.02 (.01)	-.03	-.00	.046	
Interaction effects:															
InteractionType*Interpersonal skills															
No interaction	-.01 (.01)	-.02	.01	.44		.00 (.00)	-.01	.01	.41		-.00 (.01)	-.02	.01	.81	
FtF only	.01 (.01)	-.00	.02	.23		.00 (.00)	-.01	.01	.66		-.01 (.01)	-.02	.01	.49	
Main effect															
Quantity of social interactions	.69 (.28)	.14	1.24	.015		-.60 (.23)	-1.05	-.16	.008		-.28 (.35)	-.97	.41	.43	
Interaction effects:															
InteractionType*Quantity of social interactions															
No interaction	-.05 (.29)	-.63	.59	.87		.27 (.22)	-.17	.71	.22		.29 (.38)	-.47	1.04	.46	
FtF only	.25 (.26)	-.27	.77	.34		.12 (.20)	-.27	.51	.54		-.14 (.34)	-.80	.52	.68	
Main effect															
Quality of social interactions	.58 (.02)	.49	.66	<.001		-.36 (.03)	-.42	-.29	<.001		-.36 (.05)	-.47	-.25	<.001	
Interaction effects:															
InteractionType*Quality of social interactions															
No interaction	-.03 (.05)	-.12	.06	.51		.02 (.04)	-.05	.09	.62		.04 (.06)	-.08	.15	.55	
FtF only	.05 (.04)	-.03	.12	.25		-.02 (.03)	-.08	.04	.50		-.02 (.05)	-.12	.08	.71	

FtF= Face-to-Face; CI LL = Lower limit of the 95% confidence interval around the B coefficient; CI UL = Upper limit of the 95% confidence interval around the B coefficient

Interacting face-to-face vs. interacting online (H2)

We also tested the affective differences between situations when participants were interacting face-to-face vs. when they were interacting online. The results displayed in Table 2 demonstrate how the average participant reported significantly more PA, less NA, and less loneliness in the moment that they were interacting face-to-face compared to the moment when they were interacting online (see Figure 1). However, in the comparison of the social quality scores (consisting of feeling appreciated, at ease, and belonging in online vs. face-to-face company), participants generally reported significantly *lower* quality of face-to-face interactions than of online interactions ($B(SE) = -.19 (.05)$, $p = <.001$).

Exploratory Analyses

Double social interaction effects (H3)

Then, we explored differing affect levels when participants reported interacting with face-to-face and online company simultaneously. In contrast to our expectations, participants actually reported more PA ($B(SE) = .27 (.04)$, $p < .001$) and less loneliness ($B(SE) = -.49 (.05)$, $p < .001$) when they engaged in such a 'double interaction', as compared to when they were only interacting online (see Figure 1, Table 2). Participants also generally reported more PA in such a 'double interaction' than when they were only interacting face-to-face, but they also reported more NA and more loneliness when they indicated interacting with both online and face-to-face company, as opposed to interacting with 'just' face-to-face company.

Finally, participants reported significantly higher face-to-face social interaction quality when they were in double interaction than when in face-to-face interaction only ($B(SE) = .11(.02)$, $p < .001$). Conversely, participants reported a significantly lower online social interaction quality when they were in a double interaction than when they were in online interaction only ($B(SE) = -.17(.05)$, $p < .001$).

Moderating effects of social resources (H4 & H5)

The potential roles of four social resource moderators on the affective differences between being alone and being in online interaction were assessed in an exploratory analysis, the results of which are presented in Table 3. For $\alpha = .05$, one significant negative moderation effect arose: Social support moderated the difference in PA between being alone and interacting online. This means that those with higher levels of social support might experience a greater PA increase when interacting online (compared to being alone), than those with relatively lower levels of social support. However, the rest of the moderator analyses

yielded no significant moderator effect of any social resource on any affective outcome.

Discussion

The current ESM study is unique both in its measurement of how adolescents feel while engaging in an online interaction, and in its direct comparison with how they feel in face-to-face interactions. Results indicate, on average, significant intra-individual affective differences when adolescents interact online vs. when they do not. What stands out primarily, is that PA levels are higher when interacting online vs. when alone, but lower when interacting online vs. face-to-face. Furthermore, moderator analyses yielded no strong support for either the 'rich-get-richer' or 'social compensation' hypothesis, where the affective benefit of online interaction differs depending on one's social resources. Exploratory analysis of how adolescents feel when simultaneously interacting both online and face-to-face yielded perhaps the most puzzling result: participants actually indicated experiencing *more* positive affect, and a *higher* social quality of their face-to-face company than when they were interacting online or face-to-face only.

More Positive Affect When Interacting Online Than When Alone

Participants generally reported significantly more positive affect when they were interacting online than when they were not (interacting) with anyone. This association is in line with previous studies that reported positive associations between digital communication or (inter)active social media use and affective well-being (D. Liu et al., 2019; Verduyn et al., 2017). What the current results add to this literature, is first and foremost information on the *timing* of potential affective benefits. The slightly increased average levels of PA (of about 0.15 on a 1–7 scale) happen within the moment that adolescents interact online. As such, they may represent an immediate affective benefit derived from online social interaction.

This affective benefit may indicate the immediate appeal of interacting online, reflecting adolescents' (and humans') need for connectedness (Valkenburg & Peter, 2009, 2011). We are all social beings with a need to belong (Baumeister & Leary, 1995), and digital communication likely allows for fulfillment of that need, at least to some extent, and has the potential to enable social connectedness (Clark et al., 2018). This is also reflected in the finding that, on average, participants in the current study indicated feeling substantial levels of belongingness, being at ease, and appreciation from their online interaction partners within the moment

of interaction. These micro-level associations may, in certain cases and for certain individuals, contribute to the more substantive long-term positive effects of online interaction that have been previously reported, such as increased self-esteem, perceived social support, or increased social capital (Best et al., 2014). However, results did not indicate that NA and loneliness levels differed when participants were alone vs. when they were interacting online. This suggests that while online interactions may trigger some positive emotions, they may not necessarily alleviate negative emotions or loneliness.

Worse Affect but Higher Social Interaction Quality When Interacting Online Versus Face-To-Face

The current results also provide insight into the relative social and affective experiences when adolescents were interacting solely face-to-face vs. solely online. Could it be that digital communication brings comparable benefits to face-to-face interactions? It seems not. Participants reported higher PA, lower NA, and considerably lower loneliness levels, when interacting with face-to-face company compared to online company. A plausible interpretation is that physical presence of interaction partners makes a major difference to whether social interactions are experienced as beneficial. The advantages of face-to-face interactions over online communication have also been reported in previous between-person studies (Pea et al., 2012). At the same time, however, participants rated social interaction quality (i.e., how participants felt about their company, rather than how they felt in general) higher when interacting with online as opposed to face-to-face interaction partners. This may reflect that, compared to face-to-face interactions, online interaction allows for a higher degree of selectiveness (Lieberman & Schroeder, 2020), providing adolescents with more opportunity to decide to interact with people that make them feel at ease and appreciated. This can be in contrast to face-to-face interactions at home and school, where adolescents spend much time with company that they were unable to choose.

Some additional key differences between digital communication and face-to-face interaction have been described previously that may help explain the added affective benefit of face-to-face interactions over online interactions (Lieberman & Schroeder, 2020; Valkenburg & Peter, 2009). Although it varies across the specific platform and features that are used, online interactions generally involve fewer nonverbal cues – which may relate to the diminished benefits derived from online interaction relative to face-to-face interaction. Perhaps most crucially, however, online interactions generally involve more asynchronicity, where there is a lag between the sending and receiving of information from your interaction partner. Recent behavioral conceptualizations of social interactions emphasize

how it is the direct real-time reciprocity that makes an interpersonal encounter feel truly *interactive* (De Jaegher et al., 2010; Redcay & Schilbach, 2019) – and consequently, perhaps more enjoyable. This idea is also supported by the results of an ESM study, which indicated that college students experienced interactions on the mobile platform Snapchat as more enjoyable than other online interactions (Bayer et al., 2016). The explanation that the authors offered for this finding related to the ephemeral nature of Snapchat, where content is presented for a limited time only and cannot be viewed later. This more ‘life-like’ characteristic may therefore be crucial, and it would be interesting for future work to further disentangle which characteristics of online interactions relate to more enjoyable and/or more social experiences.

Mixed Results for Simultaneous Face-to-Face and Online Interactions

Based on previous studies (Brown et al., 2016; Dwyer et al., 2018; Kushlev & Heintzelman, 2014), we expected that communicating online while also interacting face-to-face would undermine the affective and social benefits of both types of interaction. This expectation was partially confirmed, as participants reported higher levels of loneliness and negative affect when in a ‘double interaction’ compared to a ‘single’ face-to-face interaction. Additionally, we found that participants appreciated their online company less when they were also interacting with people face-to-face, suggesting that online interaction quality may also be undermined by simultaneous face-to-face interaction.

We did not, however, anticipate the reverse associations, where adolescents reported *more* positive affect when engaging in a double interaction – as compared to the experience of both online and face-to-face interactions. More surprisingly, adolescents also reported feeling more appreciated, at ease, and belonging in their current face-to-face company when they were interacting online at the same time. Further qualitative research – where, for example, adolescents are interviewed about their experiences of digital communication use – may be helpful in disentangling adolescents’ experiences of these moments.

Little support for moderating effects of social resources

In the exploratory moderator analyses, we set out to test the competing ‘rich-get-richer’/‘social compensation’ hypotheses, where those with more/fewer social resources experience a larger affective boost from interacting online. Most previous between-person studies investigating these effects have reported more positive associations between social media use and well-being for those with more social resources (Spies Shapiro & Margolin, 2014). However, when testing

these hypotheses at the within-person level, the current results do not support either hypothesis. As recent work has emphasized substantial variation in how young people experience social media (Beyens et al., 2020), it is worthwhile to further explore what individual and environmental factors explain these individual differences. Future work might primarily benefit from an idiographic approach, where the effects of digital communication on well-being are explored in greater detail within individuals (Pouwels et al., 2021; Valkenburg et al., 2021).

Strengths, Limitations, and Implications

The current study has a number of key strengths, adding to some novel contributions to the existing literature. First, the use of experience sampling to study associations between online communication and affective well-being allows for the much-needed disentangling of within- from between-person effects – and has therefore been widely encouraged as an assessment tool to investigate this relationship (Dienlin & Johannes, 2020; Odgers & Jensen, 2020b; Orben, 2020; Przybylski et al., 2019). Moreover, we are unique in using experience sampling to investigate online interactions and affective well-being in a naturalistic context, *in the moment* that those interactions occur. In addition to the substantive contributions already described, our study demonstrates that it is possible to study online interactions within the moment. Second, the analysis is transparent and reproducible, as we registered the full analysis plan, and published all R code online (<https://bit.ly/33dYEc2>). This is particularly relevant for studies on the relationship between digital communication and well-being – a field fraught with methodological and statistical issues. Third, the sample size is substantially larger than that of most existing experience sampling studies investigating the relationship between online communication and well-being. This allowed for a high-powered study, in which we were well able to investigate cross-level interactions.

However, some important limitations and challenges are worth considering. The current study has a relatively large amount of missing data, due to a low compliance to the ESM protocol. Compliance might have been increased with, for example, a longer time to respond to the questionnaire (although this does make assessments less ‘in-the-moment’), or more incentivization of completing ESM questionnaires (although this might have also led to more careless responding). Future studies may consider using shorter questionnaires to increase compliance (Eisele et al., 2020) or employing planned missingness designs (Silvia et al., 2014). In addition, missingness of the ESM prompts may be systematic (e.g., participants may be less likely to complete questionnaires when in company), and this may affect the presented results. Results from a recent study, however, suggest that this issue may not pose a huge threat to our results,

as it was found that almost none of their passively measured variables (including location, behavior, but also social interaction) significantly predicted missed prompts (Sun et al., 2021).

Finally, recent research also suggests the relevance of further investigating individual variability in the effects of digital communication on well-being, as some individuals experience an affective benefit from social media, while for others there is a weaker, no, or even an adverse effect (Beyens et al., 2020). Establishing the heterogeneity of these effects is important, as it allows for conclusions that extend beyond the one-size-fits-all recommendations derived from much between-person research. Still, in order to obtain helpful conclusions and recommendations for groups of people, we also need to learn more about the moderating factors driving the heterogeneity in (digital communication) effects.

Any implications from this study should be viewed in light of both this heterogeneity and of its scope. Although the results of this study do not speak to longer-term outcomes, they do suggest that, to momentarily boost a positive mood, going online to connect with others might be a valuable approach. At the same time, face-to-face interaction seems most effective in relieving negative mood and loneliness. This knowledge can be used, for example, in the development of better Ecological Momentary Interventions (EMIs; (Heron & Smyth, 2010; Myin-Germeys et al., 2016b), which are interventions that draw on ESM to intervene at the level of daily life. Before this knowledge can be implemented, however, we need to learn more about the causality involved – it might be that online interaction leads to more positive mood, but it is also likely that adolescents are more likely to engage in an online interaction when they are already in a positive mood. Daily-life studies that take the temporal association between CMC and momentary well-being into account are then valuable in this regard, as are studies that intervene in daily life (e.g., prompt someone to interact with others online or face-to-face) and subsequently assess the effects of this micro-level intervention.

Conclusion

The current study directly assessed the potential benefits and disadvantages of naturalistic online interactions within a large sample of adolescents. Our results highlight the potential for assessing the experience of online social interactions at the moment that young people engage in them. We observed a direct affective benefit of interacting with others online relative to being alone. At the same time, however, the results also suggest unique benefits of socializing in real life, as adolescents generally felt best when they were interacting face-to-face. While the current study precludes any causality claims, it uniquely highlights the direct experience of different types of social interactions for adolescents. More work is

needed to further illuminate both the idiosyncrasies and general tendencies in how communication technologies fulfill adolescents' universal need to connect with others – and, moreover, how this relates to well-being in the long term.

Chapter 8:

COVID-19-related changes in adolescents' daily-life social interaction and psychopathology symptoms

Article submitted and under review.

Preprint available online at:

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Supplemental materials for this Chapter are available online: <https://osf.io/faumt/>

Abstract

Early findings on the impact of the COVID-19 pandemic suggest that adolescents' mental health and day-to-day social lives are strongly affected. In this longitudinal study, we assessed changes in psychopathology, daily-life social interactions, and in the relationship between social interactions and psychopathology symptoms.

Flemish adolescents ($n=173$; mean age=16.0 in 2020; 89% girls) were tested between January 2018-June 2019; and between April 27th-May 10th 2020. Subclinical psychopathology was assessed using the Brief Symptom Inventory-53; daily social interactions were assessed in six-day experience sampling periods with ten daily questionnaires.

Multilevel linear and logistic regression analyses indicated lower general psychopathology and anxiety symptoms, beyond age effects; fewer face-to-face social interactions, more online social interactions; and higher-quality face-to-face interactions during the pandemic than before. Negative associations between psychopathology and the quality of face-to-face peer and family interactions were stronger during the pandemic than pre-pandemic.

The observed decrease and stability in psychopathology symptoms potentially reflects resilience. Results imply that high-quality face-to-face interactions with family and peers may have been more powerful in keeping adolescents resilient than online interactions. As restrictions are lifted and adolescents' daily lives and social worlds change, it is crucial to learn more about the longer-term effects of the experienced social deprivation.

Introduction

The lockdown measures associated with the COVID-19 have ignited an intense discussion about the potential short- and long-term impact of such restrictions on mental health (Brooks et al., 2020; Gunnell, Appleby, 2020; Holmes et al., 2020). However, the research that has emerged on this impact is predominantly cross-sectional and as such, is limited in its ability to inform us about the actual impact that the pandemic has had on mental health.

Emerging findings from longitudinal studies with pre- and mid-pandemic assessments – representing some of the most useful work on the mental health impact of the pandemic – diverge. An ongoing 'living' systematic review indicates conflicting findings but no overall effect of the COVID-19 pandemic on depression and anxiety symptoms (Sun et al., 2021). For adolescent samples specifically, there is also no consensus, with studies reporting increases, stability, and decreases in depression and anxiety symptoms (Barendse et al., 2021; Magson et al., 2021; Widnall et al., 2020). In sum: The evidence regarding whether mental health actually deteriorated during the COVID-19 pandemic is mixed.

Yet, across previous longitudinal studies, young people are underrepresented (Sun et al., 2021), despite evidence that young people (older adolescents and young adults, up to age 29) have experienced the greatest increases in depression and anxiety symptoms, and the greatest deterioration in their well-being, relative to older age groups (O'Connor et al., 2020).

Even without the backdrop of the COVID-19 pandemic, adolescence specifically is a significant period of vulnerability for the development of psychopathology, as almost half of all mental illnesses begin before the age of 14 (Solmi et al., 2021). Determining the impact of the pandemic on adolescents, and identifying the key risk and protective factors for youth mental health during the pandemic is critical to understanding which adolescents may need additional support – and what type of support could be most helpful. Current evidence suggests the relevance of pre-existing stressors, such as having been bullied, but also COVID-19-related stressors such as being under stricter lockdown rules (Barendse et al., 2021; Magson et al., 2021; Veer et al., 2021), for mental health outcomes during the pandemic. Additionally, social support, having a sense of connection to important others, and resilience to stressors appear crucial for maintaining good mental health during COVID-19 (Barendse et al., 2021; Magson et al., 2021; Veer et al., 2021). Confirming the relevance of these internal and external factors for psychopathological development in response to the pandemic is crucial.

As social interactions with peers have been greatly stifled by COVID-19-related restrictions, the key mechanism through which the COVID-19 pandemic may affect youth mental health, is likely social in nature (Orben et al., 2020).

This is exemplified by previous research on the effects of social isolation, which highlights how adolescents are more likely to develop anxious and depressive symptoms during and after enforced isolation (Loades et al., 2020). Conversely, receiving support from others during the pandemic has been associated with fewer depressive symptoms (Alvis et al., 2020). To uncover more about the mechanisms that may mediate the impact of COVID-19, we also need to learn more about the *changing* relationship between social interactions and psychopathology. Previous work has demonstrated how the quality and quantity of social interactions are associated with adolescent psychopathology ((Achterhof, Kirtley, Schneider, Hagemann, et al., 2021). However, the question remains to what extent such associations are maintained during a period of lockdown, and if so, which aspects of social interaction have become more vs. less relevant for predicting psychopathology.

Although much discussion on COVID-19 and mental health has centered around how the pandemic affected adolescents' day-to-day social lives, we know of no studies with data collected before and during the pandemic that have targeted social interactions where they naturally occur: in the context of everyday life. The experience sampling method (ESM; (Csikszentmihalyi et al., 1977; Myin-Germeys et al., 2018) is a dynamic approach that prompts participants at random times to provide information on their thoughts, behaviors, feelings, and environments while they go about their daily lives. As such, the ESM is uniquely suited to gain highly ecologically valid insights into adolescents' day-to-day social lives. During the pandemic, researchers have used ESM to reveal decreases in loneliness throughout the initial stages of the pandemic (Stieger et al., 2021). However, to gain insight into the impact of the pandemic on social interactions, we must also test changes in day-to-day social interactions from before to during the pandemic - as doing so allows us to make inferences about the actual effects of the pandemic on social behaviors.

Furthermore, in the assessment of changes in day-to-day social interactions, a focus on face-to-face interactions is insufficient, as, digital communication platforms may in fact provide an important alternative for young people's social behavior (Orben et al., 2020). However, it is largely unknown to what extent the COVID-19 pandemic has boosted digital communication, and to what extent online social interactions have formed worthwhile alternatives to face-to-face contact.

In the current study, we aim to investigate (1) changes in psychopathology symptoms before and during the early phase of the pandemic, (2) the potential effects of both pre-pandemic and early-pandemic risk (trauma, COVID-19-related stressors, bullying experiences) and protective (social support, interpersonal skills, resilience, posttraumatic growth) factors on psychopathology symptoms, (3) changes in the quality and quantity of social interactions,

(4) the relationships between aspects of daily-life social interactions and psychopathology symptoms, and (5) changes in those relationships pre- to early-pandemic. Research questions 1 through 3 are largely confirmatory, as we expect that (1) psychopathology symptoms have increased; (2) all risk factors are predictive of greater levels/increases in psychopathology; all protective factors are predictive of lower levels/decreases in psychopathology; (3) the quantity of offline social interactions has decreased; the quantity of online social interactions has increased. All other investigated associations are considered exploratory. To achieve our aims, we draw on longitudinal and experience sampling data from the ongoing adolescent 'SIGMA' cohort study (Kirtley et al., 2021). The combination of registered analyses (available at <https://bit.ly/3pSoQlg>), the use of both pre- and early-pandemic data, and dynamic assessments of social interactions using experience sampling methods (ESM) uniquely situates this study to provide essential, ecologically valid, and reliable knowledge on social processes and mental health during the COVID-19 pandemic.

Method

Setting

The sample in the current study was initially recruited from the Flanders (Dutch-speaking) region of Belgium, for participation in the longitudinal adolescent mental health study 'SIGMA'. Wave 1 of the study (hereafter: T0) was completed between January 2018 and June 2019. Wave 2 of the study had just commenced, in January 2020, when the global COVID-19 pandemic spread and the Belgium government implemented restrictive measures on March 18th 2020. Data collection for Wave 2 was consequently postponed. However, given the need for knowledge on adolescent mental health and social processes during the pandemic, we set up an additional wave of the study in April 2020. Participants in this additional wave of SIGMA were reassessed from home, in the week of May 4th - May 10th 2020 (hereafter: T1).

Sample

The initial, T0 sample was recruited as representative for Flemish adolescents in terms of education level and geographical spread (Kirtley et al., 2021). To recruit participants, all regular secondary education schools from the Flanders region were contacted and asked to participate, of which 22 subsequently agreed. Participants were recruited from the first (~12 years old), third (~14 years old), and fifth (~16 years old) grades, consistent with the planned accelerated longitudinal design of the SIGMA study, where different cohorts are recruited

simultaneously (Galbraith et al., 2017). The only inclusion criterion for the study involved the ability to read and understand Dutch. Informed consent was obtained from both students and parents, and the final T0 sample consisted of $n = 1913$ participants.

At T1, all participants for whom contact details were available were contacted through their supplied e-mail address at T0; if no e-mail address was available but a phone number was available, they were sent a text message. Participants were asked to participate in a special follow-up of the SIGMA study, outside of Wave 2 follow-up, in order to assess the impact of the COVID-19 pandemic on their well-being. A final sample of 173 adolescents participated at T1 (see Supplementary Material 1 available online for T1 recruitment flowchart, osf.io/faumt/). Descriptive statistics of the included $n = 173$ sample at both T0 and T1 are presented in Tables 1 and 2.

Procedure

Data collection at both waves involved two main methodologies: retrospective questionnaires on general risk/protective factors and psychopathology, administered once (per wave), and experience sampling method (ESM) questionnaires on daily-life thoughts, emotions, behavior and context, administered multiple times during participants' day-to-day life.

T0 Procedure

At T0, participants from each school were initially asked to complete all retrospective questionnaires in a 100-minute session in their classroom. At the end of this test session, participants were lent a mobile phone (Motorola Moto E4), with the ESM software (Meers et al., 2020) pre-installed, and a physical activity tracking device (Fitbit Charge 2). Researchers briefed participants on how to complete the ESM questionnaire, including by guiding participants through completion of a demo questionnaire.

The signal-contingent ESM period lasted for six days, starting on the day following the initial questionnaires, with ten ESM prompts per day. ESM prompts were presented at semi-random times, each distributed randomly within one of ten daily 90-minute blocks between 7.30 AM and 10.30 PM, with a minimum of 15 minutes between consecutive prompts. Participants were notified with either a vibration, a sound, or with both vibration and sound (they could not turn off these notifications without turning off the phone entirely); following this notification, they had 90 seconds to open the daily questionnaire, and again 90 seconds to complete each item before the questionnaire would time out. Because participants would also fill out ESM questionnaires in the classroom, all T0 prompts were scheduled at the same random times for those participants

that were in the same class to minimize class disturbance. At the end of the ESM period, participants were asked to return all study material at the end of those six days.

T1 Procedure

At T1, all data collection took place remotely. Participants were first sent all retrospective questionnaires via REDCap. Then, participants were asked to download the SEMA3 mobile application (Koval et al., 2019) onto their own phones for the ESM assessments. The distribution of daily ESM prompts was as similar as possible to the T0 ESM period, with the same signal-contingent, semi-random prompt schedule consisting of ten daily prompts distributed across six days. The daily-life part of the study consisted of a subsample of $n = 122$ participants (see Supplementary Material 1 available online for recruitment flowchart, osf.io/faumt/).

Measures

Retrospective Questionnaires - Risk and Protective Factors

Interpersonal Skills (T0)

An interpersonal skills score was calculated with the mean score on all 18 items of the 'Interpersonal Skills' subscale of the Vragenlijst Psychosociale Vaardigheden (VPV; (Scholte & Van der Ploeg, 2013). This subscale consists of the two subscales Relational Skills (e.g., 'I can get along well with different types of people'), and Affective Skills (e.g., 'I recognize in others how they feel or what they think'). The VPV 'Intrapersonal Skills' subscale was not used for the current study. All items are rated '1. Completely disagree' to '5. Completely agree'. The McDonald's Omega (total) coefficient ω was computed as a reliability indicator (Revelle & Condon, 2018), and was $\omega = .85$ for the Interpersonal Skills subscale.

Bullying (T0)

Bullying prevalence was based on one Likert-type scale question, asking whether participants have ever been bullied (T0; Wave I). Answer options were (Never; Almost never; Sometimes; Regularly; Often)

Trauma (T0)

A total trauma score was calculated through a sum score on all 34 items of the Juvenile Victimization Questionnaire (Hamby et al., 2004). Items were phrased as 'Has [trauma] ever happened to you?'; to which participants could respond yes/no, where yes is scored as 1, and no as 0. Reliability of the total scale was good ($\omega = .85$).

Social Support (T0)

A total social support score was calculated by taking the mean score on all 12 items of the Social Support List-Interactions (SSL-I-12; (Van Sonderen, 2012). The list consists of three subscales: Daily support (e.g., 'How often does it happen that people show interest in you?'); Support with problems (e.g., 'How often does it happen that people give you good advice?'); and Appreciation (e.g., 'How often does it happen that people compliment you?'). All items are scored from '1. Rarely or never' to '4. Very often'. Reliability of the total score was good ($\omega=.88$).

Social Support (T1)

At T1, a different social support measure was used: the Multidimensional Scale of Perceived Social Support (MSPSS; (Zimet et al., 1988). The MSPSS consists of 12 items from three subscales: 'Significant others' (e.g., 'There is a special person that helps me when I am in need'); 'Family' (e.g., 'My family gives me the emotional support that I need'); and 'Friends' (e.g., 'I can talk to my friends about my problems'). All items are scored from '1. Completely disagree' to '5. Completely agree'. An average social support score is calculated by taking the mean across all 12 items ($\omega=.94$).

COVID-19-Related Stressors (T1)

A questionnaire on COVID-19-related stressors was adapted from the DynaCORE survey on resilience in the corona crisis of the DynaMORE project (<https://dynamore-project.eu/>; (Veer et al., 2021). This questionnaire assesses 22 potential problems that may have arisen in the past two weeks, due to the consequences of the COVID-19 pandemic, such as having potential COVID-19 symptoms, being unable to see people, or family tension. The original questionnaire from the DynaCORE also contains eight additional items that we omitted, as they were not applicable for an adolescent sample (e.g., 'Problems arranging childcare', 'Business travel not possible'). All items were first scored as 0 ('This situation has not happened') or 1 ('This situation has happened'). Severity was rated for all endorsed items with 'How much has this situation troubled you?', rated from 1 ('No trouble at all') to 5 ('Troubled me greatly'). A stressor count score was created by adding up all of the endorsed items ($\omega=.53$); a stressor severity score was created by weighting each endorsed item by the extent to which it was experienced as a burden, and then summing these weighted items. This latter stressor severity score was used in subsequent analyses. The full COVID-19 related stressor questionnaire is included in Supplementary Material 2 available online (osf.io/faumt/).

Posttraumatic Growth (T1)

Posttraumatic growth was assessed with the 10-item Posttraumatic Growth

Inventory - Short Form (Cann et al., 2010). Participants were asked to what extent changes have taken place in their lives as a consequence of the COVID-19 pandemic and its associated measures. This scale consists of 5 subscales, with 2 items per subscale: Relating to Others, New Possibilities, Personal Strength, Spiritual Change, and Appreciation of Life. All items are scored from '1. Not experienced' to '6. Yes, strongly experienced'. We used a total score only, defined as the average score across all 10 items ($\omega=.88$).

Resilience (T1)

Resilience was assessed with the 16-item Child & Youth Resilience Measure Revised (unvalidated Dutch translation of the questionnaire developed by (Jefferies et al., 2019), which consists of the two subscales 'intra/interpersonal' (e.g., 'I feel supported by my friends') and 'caregiver' (e.g., 'My caregiver(s) stand by me during difficult times') resilience. Items are all scored from '1. Not at all' to '5. Very much'. One total score is created for each person by averaging the scores to each item ($\omega=.93$).

Retrospective Questionnaire - Mental Health Outcome

Psychopathology Symptoms (T0 and T1)

At both waves, the Dutch-language version of the Brief Symptom Inventory-53 (L.R. Derogatis, 1993) was used to assess different dimensions of psychopathology. The BSI-53 includes nine dimensions, but as registered, we only looked at the major dimensions of depression, anxiety, and psychoticism more specifically, consistent with the symptomatology that has received most attention in the emerging COVID-19 and mental health literature. BSI items are rated on a scale from 0 ('Not at all') to 4 ('Very much'). For T0 (Wave I), the phrasing of items follows the original item definitions, asking 'Including today, how much did the following problem trouble you in the last week?' For T1, the time reference was changed so that every symptom referred to asking which problems have troubled participants 'since the first corona measures (March 13)'. A total symptom score (General Severity Index; GSI) consists of the mean across all SCL-90 items. . Reliability for all subscales and total scores were good (T0 depression, $\omega=.93$; T0 anxiety, $\omega=.88$; T0 psychoticism, $\omega=.79$; T0 GSI, $\omega=.97$; T1 depression, $\omega=.93$; T1 anxiety, $\omega=.91$; T1 psychoticism, $\omega=.78$; T1 GSI, $\omega=.97$).

Experience Sampling - Social Variables

At both T0 and T1, participants were prompted with ESM questionnaires largely pertaining to the moment right before they were prompted. For the current study, we use the face-to-face and online social items (full ESM questionnaire is provided in Supplementary Material 3, available online osf.io/faumt/).

Face-to-Face Company and Interactions

ESM items were used to construct the dichotomous variables 'face-to-face social interaction' (i.e., is someone socially interacting at any given moment? yes/no, indicated by a 2 or higher on the item 'we are doing something together'), 'face-to-face peer interaction', and 'face-to-face family interaction'; and the continuous variables of 'face-to-face interaction quality', 'face-to-face peer interaction quality', 'face-to-face family interaction quality' (all by taking the mean on the three interaction quality items [feeling at ease, appreciation, belonging in company], per context). As indicators of within- and between-person reliability, McDonald's Omega coefficients were calculated for the face-to-face interaction quality at both time points: at T0, $\omega_{within} = .88$, and $\omega_{between} = .93$; at T1, $\omega_{within} = .88$, and $\omega_{between} = .99$. The intraclass correlation coefficient (ICC) for mean face-to-face interaction quality was .31 at T0, and .44 at T1. See Supplementary Material 4 available online (osf.io/faumt/) for exactly how these variables were constructed.

Online Interactions

At each T0 and T1 ESM prompt, participants were also asked to indicate whether they were in an online interaction, and how much they felt at ease, appreciation, and belonging to the people that they were in online contact with. The following momentary online interaction variables (similarly as for the face-to-face interaction) were then created: 'online social interaction', 'online peer interaction', and 'online family interaction', 'online interaction quality', 'online peer interaction quality', 'online family interaction quality'. McDonald's Omega coefficients for the online interaction quality indicated sufficient reliability: At T0, $\omega_{within} = .87$, and $\omega_{between} = .93$; at T1, $\omega_{within} = .88$, and $\omega_{between} = .98$. The ICC for mean online interaction quality was .38 at T0, and .16 at T1. The relatively lower ICC at T1 indicates a lower proportion of within-person variance – thus, more between-person than within-person differences in the mean quality of online social interactions in the early stages of the pandemic.

Power Analysis

Given the absence of comparable literature from which to draw parameters for a power analyses and because our analytic options were dependent upon the number of participants, we conducted sensitivity power analyses (Lakens, 2021) following data collection but before data access, for two hypothesis tests: For H1, testing the changes in T0 to T1 psychopathology; and for H4a, testing the changes in the quantity of social interactions from T0 to T1. We first calculated the minimum effect sizes that could be detected for $n = 171$, power = .80, and $\alpha = .05$. For H1, we found that we were able to reliably detect an effect size of $d = .19$. We also conducted an alternative simulation-based power analysis,

which demonstrated that we would be able to detect increases of 35%-36% in psychopathology levels (with .80 power). For H4, we also conducted a simulation-based power analysis, which demonstrated that we had .85 power to detect a relatively small decrease of 3% in the quantity of social interactions (for the $n = 122$ participants with ESM data). All R code pertaining to the estimation of parameter estimates and the power analysis have been made available on the OSF-page for this project (<https://bit.ly/3pNSgEU>).

Statistical Analysis

Missing Data Imputation

As much questionnaire data was missing (notably, due to the time constraint when filling out the retrospective questionnaires) we considered a missing data imputation method to be appropriate (van Ginkel et al., 2020). For the missing data on all non-ESM questionnaires (i.e., social support, trauma, bullying, interpersonal skills, COVID-19-related stressors, resilience posttraumatic growth, psychopathology), we imputed data in 20 datasets at the item-level, based on the information of all other included variables, using a multiple imputation model by chained equations (MICE), carried out with the latest available version of the 'mice'-package (v. 3.12.0; (van Buuren & Groothuis-Oudshoorn, 2011) in R. Across these 20 imputed datasets, analyses were subsequently performed and the pooled estimates are reported (following Rubin's rules; (Rubin, 1987).

Changes in Psychopathology

To assess significant changes in psychopathology from T0 to T1, we estimated three linear mixed-effects models, where change in the mean level of psychopathology (total, depression, anxiety, or psychosis) is assessed from T0 to T1, including T1 age and gender as covariates. By including age as a covariate, we are able to assess whether psychopathology has increased beyond what could be expected based on age alone (as older adolescents generally report more psychopathology than younger adolescents). When testing these hypotheses (and all hypotheses below), Holm's multiple comparison correction was applied, for four tests (for each type of psychopathology) with an initial $\alpha = .05$.

Associations Between Risk/Protective Factors and Psychopathology

For the research questions on the association between T1 psychopathology and T0 and T1 risk and predictive factors, we first estimated a linear regression

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model where T1 COVID-19-related stressor severity score (weighted by perceived stressor burden), resilience, posttraumatic growth, and social support simultaneously predicted T1 psychopathology, and where T1 age and gender were included as covariates; second, we similarly estimated a linear regression model where T0 trauma, bullying, interpersonal skills, and social support simultaneously predicted T1 psychopathology - and where T0 psychopathology, and T1 age and gender were included as covariates. All these variables are time-invariant, and all continuous predicted variables were centered prior to the analyses.

Analyses on Daily-Life Social Quantities and Qualities

For the ESM-based analyses, the first aim was to assess whether changes have happened in the quantity and quality of social interactions from T0 to T1. We employed multilevel (mixed effects) models, with moments nested within persons. To test whether participants generally spent more or less time in the company of others online or offline at T1 compared to T0, each of six moment-level dichotomous social company/interaction variables was predicted by a factor variable representing T0 and T1 in separate logistic multilevel regressions. To test whether participants' quality appraisals of offline and online interactions have changed from T0 to T1, each of six momentary mean social quality scores was predicted by a factor variable representing T0 and T1 in separate multilevel linear regressions. Then, to test the association between psychopathology and each social outcome, the person-level psychopathology variable was added to each of the 12 models described. Finally, in order to assess whether the relationship between psychopathology and social interaction variables changed from T0 to T1, the interaction between psychopathology and a factor variable representing T0 and T1 was again added to the same 12 models. In all multilevel models, continuous predictor variables (age, psychopathology) were person-mean centered. Age and sex were added as covariates to all models. Also, errors were assumed to be Gaussian distributed and serially correlated with an autoregressive AR(1)-component.

Open Science Practices

All analyses were registered before full data access (also referred to as 'post-registration'; (Benning et al., 2019). At the time of registration, the authors had had access to all T0 variables - but not the main T1 variables of interest (only to the covariates of age and sex). The registration details of both the power analysis and all other performed analyses are available online (<https://bit.ly/3pNSdsl>). All R code used to perform the analyses is uploaded to the OSF-page of this project (<https://bit.ly/3pNSgEU>). Both the retrospective questionnaires and the full list

of ESM items can be found in Appendices B and C. All ESM items from Wave 1 of the SIGMA project can also be found in the ESM Item Repository (www.esmitemrepository.com; Kirtley et al., 2021).

Deviation From Registration

We deviated from our registered analyses in the following respect: In our registration we described that we would use linear growth curve analyses. However, we later realized that such models require at least three time points (Curran et al., 2010), whereas we have two time points. Therefore, we estimated linear mixed-effects models with 'study/wave' included as a separate independent variable.

Results

Summary information for all variables is described in Tables 1 and 2. Correlations between all included risk/protective and psychopathology variables are included in Supplementary Material 5, Tables 3 and 4.

We also assessed post-hoc whether there were differences between the $n=173$ sample included at both T0 and T1 and the $n=1740$ participants who participated at T0 but not at T1. Generally, participants who re-enrolled at T1 were older, more likely to be female, and reported higher levels of T0 depression, psychoticism, and general psychopathology (see Supplementary Material 6 for full results). As both higher age and being female were related to higher levels of psychopathology, we also tested whether increased T0 psychopathology levels still predicted re-enrollment at T1, when controlling for age and gender. None of those associations were significant, indicating that - taking age and gender into account - participants with more T0 psychopathology were not more likely to re-enroll at T1.

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Table 1: Descriptives of all included variables at both waves

Variables	T0 sample (n = 173)			T1 sample (n = 173)		
	Mean (SD)	Median	Range	Mean (SD)	Median	Range
Age	14.2 (1.8)	14.0	11.0 - 18.0	16.0 (1.9)	16.0	13.0 - 20.0
Gender (%girls)	88.4			89.0		
Interpersonal skills (VPV)	69.4 (7.5)	69.0	53.0 - 90.0	-	-	-
Social support (T0: SSL-I-12; T1: MSPSS)	22.8 (6.0)	23.0	5.0 - 36.	59.7 (14.6)	60.0	12.0 - 84.0
Bullying (Short Bullying List)	1.3 (1.3)	1.0	0.0 - 4.0	-	-	-
Trauma (JVQ)	6.3 (4.9)	5.0	0.0 - 19.0	-	-	-
COVID-19-related stressors (weighted severity score)	-	-	-	6.5 (2.2)	6.6	0.0 – 12.2
Posttraumatic growth (PTGI-SF)	-	-	-	24.5 (9.3)	23.0	10.0 - 55.0
Resilience (List)	-	-	-	62.9 (12.2)	64.0	17.0 - 85.0
Depression (BSI-53)	1.0 (1.0)	0.7	0.0 - 3.50	1.2 (1.0)	0.8	0.0 - 4.0
Anxiety (BSI-53)	1.0 (0.8)	0.8	0.0 - 3.3	0.9 (0.8)	0.6	0.0 - 3.3
Psychoticism (BSI-53)	0.9 (0.8)	0.6	0.0 - 3.2	0.9 (0.9)	0.6	0.0 - 3.4
Psychopathology – total (BSI-53)	1.0 (0.7)	0.9	0.0 - 3.4	1.0 (0.7)	0.8	0.0 - 2.9

Table 2: Descriptives of the included momentary (aggregated within-person) variables.

Variable	T0 sample (n=168)				T1 sample (n=110)			
	n	Mean (SD)	Median	Range	n	Mean (SD)	Median	Range
# of completed ESM prompts (out of 60)	168	30.8 (12.7)	32.0	5 - 59	110	27.7 (16.2)	27.0	1 - 59
Quantity of FtF interactions ^a	168	.73 (.17)	.72	.29 - 1.00	110	.44 (.25)	.42	0.00 - 1.00
Quantity of FtF family interactions ^b	168	.33 (.17)	.34	.00 - .69	109	.60 (.29)	.67	0.00 - 1.00
Quantity of FtF peer interactions ^b	168	.81 (.19)	.86	.25 - 1.00	109	.08 (.15)	.00	.00 - .80
Quantity of all online interactions ^a	168	.26 (.24)	.19	.00 - 1.00	110	.44 (.27)	.39	.00 - 1.00
Quantity of online family interactions ^c	-	-	-	-	106	.03 (.09)	.00	.00 - .80
Quantity of online peer interactions ^c	-	-	-	-	106	.65 (.29)	.71	.00 - 1.00
Quality of all FtF interactions	168	5.89 (.87)	6.02	3.11 - 7.00	103	5.96 (1.15)	6.42	2.08 - 7.00
Quality of FtF family interactions	156	6.20 (.94)	6.51	2.67 - 7.00	101	5.94 (1.21)	6.33	1.00 - 7.00
Quality of FtF peer interactions	168	5.69 (1.03)	5.91	2.74 - 7.00	44	5.90 (1.49)	6.50	1.00 - 7.00
Quality of online interactions	144	6.03 (1.01)	6.26	2.00 - 7.00	106	5.77 (1.07)	6.00	1.00 - 7.00
Quality of online family interactions	-	-	-	-	17	5.84 (1.47)	6.22	1.00 - 7.00
Quality of online peer interactions	-	-	-	-	90	5.63 (1.49)	6.10	1.00 - 7.00

FtF = Face-to-Face

- a. As % of all compliant ESM prompts
- b. As % of all offline interactions
- c. As % of all online interactions

Changes in Psychopathology Pre- to Early-Pandemic - Beyond Age Effects

We observed a significant decrease in anxiety symptoms and general psychopathology symptoms from T0 to T1, after age effects were also taken into account (Table 3). Results demonstrated no significant changes in either depression or psychotic symptoms across waves.

Table 3: Linear regression analyses results, on the changes in psychopathology from T0 to T1. Significant *p*-values following Holm's multiple comparison correction are displayed in bold.

	Depression		Anxiety		Psychoticism		Total score (GSI)	
	β (SE)	<i>p</i>	β (SE)	<i>p</i>	β (SE)	<i>p</i>	β (SE)	<i>p</i>
T1 - T0 change	-.64 (.57)	.26	-1.75 (.50)	<.001	-.52 (.43)	.23	-.20 (.07)	.004

Table 4: Two separate linear regression model results: first, predicting total psychopathology (GSI) during the COVID-19 pandemic from a set of contemporaneous risk factors; second, predicting GSI from T0 total psychopathology, and from a set of T0 risk factors. Significant *p*-values following Holm's multiple comparison correction are displayed in bold.

		T1 GSI	
Predictors		β (SE)	<i>p</i>
T1	Resilience	-.02 (.01)	<.001
	Social support	-.00 (.00)	.51
	Posttraumatic growth	.01 (.00)	.20
	COVID-19 stressors (weighted severity score)	.12 (.02)	<.001
T0	GSI	.44 (.08)	<.001
	Trauma	-.00 (.01)	.71
	Bullying	.05 (.04)	.19
	Social support	-.01 (.01)	.22
	Interpersonal skills	.00 (.01)	.75

Associations Between Early-Pandemic Risk Factors and Early-Pandemic Psychopathology Levels

In the analyses focusing on the associations between T1 total psychopathology symptoms and T1 risk and protective factors, psychopathology was significantly and negatively associated with resilience, and significantly and positively associated with COVID-19-related stressor severity (Table 4). Analyses do not

support a significant relationship between psychopathology symptoms and either social support or posttraumatic growth. In an additional post-hoc analysis, we replaced the COVID-19-related stressor severity score with the COVID-19-related stressor count score (so unweighted for severity) in the prediction of T1 psychopathology. Here, the COVID-19-related stressor count score still significantly predicted T1 psychopathology (see Supplementary Material 7 for results).

Associations Between Pre-Pandemic Risk Factors and Changes in Psychopathology Levels From Pre- to Early-Pandemic

T0 total psychopathology significantly predicted T1 total psychopathology during the pandemic (Table 4). No T0 risk or resilience factor predicted early-pandemic psychopathology when also taking into account psychopathology at the previous time point.

Changes in the Quantity of Social Interactions Pre- to Early-Pandemic

In the early phase of the pandemic at T1, adolescents reported fewer face-to-face social interactions overall, and fewer face-to-face interactions with peers than at T0. On the other hand, they reported more face-to-face interactions with family members, and more online social interactions overall. See Table 5 for further details.

Table 5: Logistic multilevel regression results, indicating changes in the quantity of social interactions from T0 to T1. Significant *p*-values following Holm's multiple comparison correction are displayed in bold.

	Quantity of FtF interactions (overall)		Quantity of FtF interactions (peers)		Quantity of FtF interactions (family members)		Quantity of Online interactions (overall)	
	<i>β</i> (SE)	<i>p</i>	<i>β</i> (SE)	<i>p</i>	<i>β</i> (SE)	<i>p</i>	<i>β</i> (SE)	<i>p</i>
T1 - T0 change	-1.22 (.09)	<.001	-4.88 (.18)	<.001	1.45 (.09)	<.001	.74 (.12)	<.001

FtF = Face-to-Face

Changes in the Quality of Social Interactions Pre- to Early-Pandemic

On average, participants indicated a higher mean quality of all their reported face-to-face social interactions during the pandemic than before the pandemic (Table 6). Specifically, the quality of face-to-face interactions with peers increased significantly. For face-to-face interactions with family members, and for online interactions, there are no significant changes in the quality.

Table 6: Linear multilevel regression results, indicating changes in the quality of social interactions from T0 to T1. Significant p-values following Holm’s multiple comparison correction are displayed in bold.

	Quality of FtF interactions (overall)		Quality of FtF interactions (peers)		Quality of FtF interactions (family members)		Quality of Online interactions (overall)	
	β (SE)	p	β (SE)	p	β (SE)	p	β (SE)	p
T1 - T0 change	.21 (.08)	.005	.41 (.14)	.004	-.09 (.08)	.23	-.15 (.09)	.09

FtF = Face-to-Face

Early-Pandemic Associations between Total Psychopathology and the Quality and Quantity of Social Interactions

We found no statistically significant association between T1 psychopathology and the quantity of T1 social interactions – neither face-to-face, online, nor across all interactions or interactions only with family members or peers (Table 7). In contrast, T1 psychopathology was negatively associated with the quality of most types of social interactions – both when offline and online, and both across all interactions and when with family members and peers (Table 8). Only the quality of online social interactions with family members was not significantly predicted by total psychopathology levels.

Changes in the Associations Between Psychopathology and the Quantity and Quality of Social Interactions Pre- to Early-Pandemic

The interaction effects in Tables 7 and 8 reveal several differences in the relationship between psychopathology and aspects of daily-life social interactions across waves. First, the positive interaction effect when predicting the quantity of face-to-face peer interactions indicates that the negative relationship

Table 7: Multilevel logistic regressions indicating the associations between BSI total psychopathology and the quantity of social interactions, all as assessed at T1 (Model 1); and multilevel logistic regressions, predicting the quantity of social interactions from time point, GSI, the interaction between time point and BSI (indicating the difference in the relationship between GSI and social outcome T1 vs. T0), and the covariates of age and gender (Model 2). Significant p-values following Holm's multiple comparison correction are displayed in bold; $p < .05$ is in italics.

	FtF interactions (overall)			FtF interactions (peers)			FtF interactions (family)			Online interactions (overall)			Online interactions (peers)			Online interactions (family)		
	β	(SE)	<i>p</i>	β	(SE)	<i>p</i>	β	(SE)	<i>p</i>	β	(SE)	<i>p</i>	β	(SE)	<i>p</i>	β	(SE)	<i>p</i>
Model 1																		
T1 GSI	-.35	(.15)	.018	-.05	(.30)	.86	-.42	(.19)	.026	.38	(.17)	.026	.11	(.22)	.62	.41	(.43)	.34
Model 2																		
T1 - T0 change	-1.31	(.09)	<.001	-5.60	(.28)	<.001	1.39	(.09)	<.001	.80	(.12)	<.001	-	-	-	-	-	-
GSI	-.40	(.09)	<.001	-.18	(.19)	.34	-.37	(.10)	<.001	.54	(.10)	<.001	-	-	-	-	-	-
GSI * Change	.04	(.09)	.65	.59	(.20)	.003	-.11	(.10)	.31	.13	(.10)	.16	-	-	-	-	-	-

FtF = Face-to-Face

Table 8: Multilevel linear regressions indicating the associations between BSI total psychopathology and the quality of social interactions, all as assessed at T1 (Model 1); and multilevel linear regressions, predicting the quality of social interactions from time point, GSI, the interaction between time point and BSI (indicating the difference in the relationship between GSI and social outcome pre- to early-pandemic), and the covariates of age and gender (Model 2). Significant p-values following Holm's multiple comparison correction are displayed in bold; $p < .05$ is in italics.

	FtF interactions (overall)			FtF interactions (peers)			FtF interactions (family)			Online interactions (overall)			Online interactions (peers)			Online interactions (family)		
	β	(SE)	<i>p</i>	β	(SE)	<i>p</i>	β	(SE)	<i>p</i>	β	(SE)	<i>p</i>	β	(SE)	<i>p</i>	β	(SE)	<i>p</i>
Model 1																		
T1 GSI	-.92	(.11)	<.001	-1.32	(.23)	<.001	-.92	(.13)	<.001	-.51	(.12)	<.001	-1.04	(.17)	<.001	-1.01	(.49)	.051
Model 2																		
T1 - T0 change	.11	(.07)	.11	.19	(.14)	.16	.19	(.08)	.010	-.19	(.09)	.024	-	-	-	-	-	-
GSI	-.66	(.08)	<.001	-1.15	(.16)	<.001	-.70	(.08)	<.001	-.35	(.08)	<.001	-	-	-	-	-	-
GSI * Change	-.16	(.07)	.027	-.56	(.16)	<.001	-.31	(.07)	<.001	-.03	(.09)	.71	-	-	-	-	-	-

FtF = Face-to-Face

between psychopathology and the quantity of face-to-face peer interactions was significantly weaker (i.e., less negative) at T1 than at T0 (Table 7). The other interaction effects between social interaction quantity and psychopathology were non-significant, indicating no evidence for weaker (or stronger) relationships between social interaction quantity and psychopathology across waves. Then, associations between psychopathology and the quality of all types of social interactions were all significant and negative – and, when predicting the quality of family and peer interactions, these associations were stronger (i.e., more negative) during than before the pandemic (Table 8). This interaction effect did not hold for the negative association between psychopathology and the quality of face-to-face interactions overall, or for the association between psychopathology and the quality of online interactions.

Exploratory Analyses

Because mean GSI and anxiety scores did not differ greatly across waves (Table 1), we conducted exploratory post-hoc analyses to examine the extent to which significant decreases were due to age effects – as older participants generally reported more symptoms. When age was excluded as a covariate from these analyses, there was no longer a significant decrease in GSI ($B(SE) = -.07 (.05)$, $p = .18$), while there was still a significant decrease in anxiety symptoms ($B(SE) = -1.10 (.40)$, $p = .007$).

In an additional post-hoc analysis, we assessed to what extent the relative decrease in GSI scores across waves was due to the anxiety items included in the construction of the GSI. To this end, we first computed a new GSI score where all six anxiety items were excluded, and then we tested whether there was a cross-wave change in this new GSI score (representing the mean across all 47 non-anxiety BSI-53 items). For this new score, we also observed a relative decrease across waves, after taking into account age effects ($B(SE) = -.19 (.07)$, $p = .007$).

Discussion

By building on an existing longitudinal study and using ESM, we have been able to gain unique insights into how the COVID-19 pandemic has affected adolescents' mental health and social interactions in daily life. Surprisingly, anxiety and general psychopathology symptoms were lower than would be expected based on age from pre- to early-pandemic, while depression and psychoticism symptoms did not significantly change. In fact, anxiety symptoms even decreased without taking into account age effects. When investigating

general psychopathology symptoms, we found that resilience and COVID-19-related stressors were significantly associated with contemporaneous general psychopathology symptoms. However, none of the pre-pandemic risk and protective factors we investigated significantly predicted change in general psychopathology symptoms during the early phase of the pandemic.

As expected, we observed significant changes in the amounts of social behaviors adolescents engaged in: they reported fewer face-to-face social interactions overall, fewer face-to-face interactions with peers, more face-to-face interactions with parents, and more online social interactions. However, adolescents also reported a higher *quality* of social interactions overall, and more specifically, a higher quality of face-to-face interactions with peers. Moreover, the negative relationships between psychopathology symptoms and the quantity and quality of some types of face-to-face interactions were stronger during the pandemic than before, highlighting the heightened importance of qualitative face-to-face interactions with close others during the COVID-19 pandemic.

Decrease in Anxiety Symptoms and Less Overall Symptoms Than Expected

We were surprised to observe a decrease in anxiety symptoms, and lower than expected general psychopathology symptoms. Previous early-pandemic studies have reported high levels of adolescent psychopathology and anxiety symptoms (e.g., (Waite et al., 2021). However, since many of these studies have no pre-COVID-19 data, their results may reflect the moderate to high levels of adolescent psychopathology already present in adolescent populations before the pandemic (e.g., (Kessler et al., 2005; Solmi et al., 2021). Where studies have been able to combine pre- and early-pandemic data on psychopathology symptoms, results are limited and conflicting. One study reported increases in anxiety levels pre- to early-pandemic (Magson et al., 2021), while other studies have reported decreases (Widnall et al., 2020) or stability in anxiety symptoms (Barendse et al., 2021; Bignardi et al., 2020).

Despite the inconsistencies across studies, it appears that, for some young people, anxiety levels have decreased pre- to early- or mid-pandemic. One potential explanation for this is that for many young people - particularly those struggling with social anxiety - their 'normal' situation of going to school induces anxiety (Morrisette, 2020). Consequently, anxiety may have decreased due to the reduced opportunities and expectations for peer interactions during the lockdown. Whilst respite from social stressors may have reduced anxiety during the early phase of the pandemic, this effect is likely to be short-term, as when schools reopen, adolescents may be less well-equipped to engage with others (Loades & Reynolds, 2021; Morrisette, 2020). Therefore, adolescents -

particularly those who already experienced anxiety before the pandemic - should be adequately supported as they return to school.

Resilience and COVID-19-related Stressors Are Significantly and Contemporaneously Associated With Psychopathology Symptoms

In trying to understand why the mental health of most adolescents in this study did not worsen during the early phase of the pandemic, it is worthwhile to examine relevant risk and protective factors. However, none of the investigated pre-pandemic risk and protective factors were significant predictors. This may be because, generally, there was not much change in psychopathology levels, and as such, little change to predict. Interestingly, our measures of resilience and COVID-19-related stressors (but neither social support nor posttraumatic growth) were significantly associated with contemporaneous psychopathology levels. The significant association of psychopathology with COVID-19 stressors (e.g., having a family member with [increased risk for] COVID-19) highlights the relevance of external factors for adolescent well-being. Moreover, the significance of resilience might also reflect more external than internal resilience factors, as this measure included many items on social support, and as the correlation with our social support measure was quite high (i.e., 0.70; see Supplementary Material 5). Therefore, despite the non-significance of the association between social support and psychopathology, strong social networks are still likely important factors in safeguarding adolescents' mental health during the pandemic - in line with previous work evidencing this link (Veer et al., 2021).

Changes in Daily Social Interactions

Our investigation and comparison of daily-life social interactions both before and during the pandemic allows us to gain a more in-depth view of changes in social behaviors and experiences during the COVID-pandemic. Unsurprisingly, during the pandemic, adolescents spent less time interacting face-to-face, both in general and with peers, and more time interacting with their family. What was somewhat surprising, was that the mean *quality* of face-to-face social interactions (both in general and with peers) had increased. One potential explanation for this might be that, during the social restrictions, adolescents were more selective in the peers that they are with, and as such, chose to interact more with closer friends or romantic partners - people who would make them feel a greater sense of ease, appreciation, and belonging. Alternatively, adolescents may have had a greater appreciation for their peers when they did get the rare opportunity to meet them.

In addition, adolescents interacted more with others online during than pre-pandemic. Connection with close others is of crucial importance for adaptive development (Baumeister & Leary, 1995), especially during a crisis situation such as the COVID-19 pandemic. Online communication with close others has likely served as a valuable placeholder of social connection when face-to-face interactions were restricted - and this may be one of the reasons why so many adolescents have remained resilient.

Relationships Between Psychopathology and Quantity and Quality of Daily Social Interactions

Results indicated how, for both online and face-to-face interactions, psychopathology levels were related to the quality but not the quantity of social interactions. The association between psychopathology and daily-life social interaction quality had been established pre-pandemic (Achterhof, Kirtley, Schneider, Hagemann, et al., 2021), but now, we also see it during this period of social deprivation. Interestingly, pre-pandemic, it was observed that those with higher psychopathology levels reported fewer face-to-face interactions - but this relationship weakened and became non-significant in the pandemic, particularly for peer interactions. The change in the relationship between psychopathology and the amount of peer interactions may be explained by all adolescents having very limited opportunities to see peers - both those with low and those with high psychopathology levels.

We also see that psychopathology was related to the quality of interactions with both peers and with family members. Also, the specific associations between psychopathology and face-to-face (but not online) interactions with both peers and family members have strengthened. This could mean that, although online tools may still provide a meaningful way of staying in touch with others during lockdown periods (Cauberghe et al., 2021; Orben et al., 2020), the fewer opportunities for face-to-face social interaction with close others seems to have become increasingly valuable.

Strengths and Limitations

A major strength of the current study is the longitudinal cohort design, meaning that we were able to compare data from Wave I (pre-COVID-19) with data collected during the early phase of the COVID-19 pandemic in order to investigate changes in psychopathology symptoms and social interaction. To the best of our knowledge, this is one of the few published adolescent studies to date on mental health and COVID-19 where comparisons could be made with data collected from the same individuals prior to the pandemic.

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As much as possible, we used open science practices within this research. Specifically, the research questions, hypotheses and analysis plans for the data presented within the current study were post-registered (Benning et al., 2019), i.e. following data collection but prior to data access and analysis, although we initially had in mind to make a pre-data collection pre-registration. We have also shared analysis code and measures on the Open Science Framework and all ESM items used in Wave 1 of the SIGMA study are publicly available online in the ESM Item Repository (Kirtley, Hiekkaranta, et al., 2020).

Despite these strengths, an important limitation needs to be considered when interpreting the results. Critically, our sample only reflects a subsample of 9% of the larger SIGMA dataset. As such, there is a high risk of sampling bias. After controlling for age and sex, psychopathology levels did not significantly predict the likelihood to re-enter the study at T1 (further details of these analyses are described in Supplementary Material 6). However, it is still plausible that, compared to participants who re-enrolled, those who did not re-enroll had larger declines or increases from T0 to T1 in their mental health - and we are currently not able to assess this.

Implications and Future Directions

The current results have several important implications. First, it appears that - at least in the initial stages of lockdown - adolescents generally remained resilient and did not experience a worsening of their mental health. However, as social restrictions have continued far beyond the period assessed in this study, we should not assume that this resilience is permanent. Adolescents have missed out on many opportunities for social interactions with peers - a fundamental developmental task (Blakemore & Mills, 2014) - and this may be related to psychological distress in the medium- to long-term. Moreover, as restrictions are lifted and adolescents go back to school and work, they may experience some levels of distress and anxiety. Those adolescents who experienced the highest levels of COVID-19-related distress reported the most psychopathology symptoms, and they may represent the group that could benefit most from treatment and intervention programmes. For future work, it is crucial to learn more about the medium and longer-term effects of the social deprivation produced by pandemic-related regulations.

Although it has been previously suggested that digital communication has buffered much of the quarantine-induced distress, the current results also suggest that high-quality face-to-face interactions with family and peers may have actually been more helpful in keeping adolescents resilient. This also implies that those adolescents who have fewer opportunities for qualitative social interactions at home may actually be at increased risk for developing distress.

In developing interventions during periods of social deprivation, it is therefore crucial to consider the importance of opportunities to physically meet close others. However, as this may not always be possible to the fullest extent, better digital youth mental health interventions are also required - as their effectiveness is currently still limited.

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Chapter 9:

Concluding Discussion

9.1 Preface

Within this PhD project, I have focused on the overarching aim of investigating face-to-face and online social interactions in the daily lives of adolescents, and of exploring which aspects of those interactions are linked to both parenting and psychopathology. In this final chapter, I will first provide a summary of the findings reported within this PhD – and how they answer the following three objectives as laid out in **Chapter 2**:

Objective 1: To assess the relationships between parenting characteristics, psychopathology, and daily-life social processes in adolescents

Objective 2: To assess differential momentary affective well-being when adolescents engage in face-to-face vs. online social interactions

Objective 3: To assess the impact of the COVID pandemic on adolescents' daily social interactions and psychopathology levels

Subsequently, I will conclude with some of the most notable implications, pertinent remaining questions, and suggestions for future research.

9.2 Summary of main findings

First, within **Chapter 3**, we set the stage by arguing how we need more naturalistic measures of social outcomes. In this chapter, we discussed how traditional tasks that measure social cognition are insufficiently ecologically valid, and how the assessment of social dysfunction would benefit from using alternative methods such as ESM. This argument is discussed in this chapter specifically for assessing social cognition in psychosis, but is broadly relevant for the assessment of social outcomes in all types of psychopathology.

Then, the first objective of this PhD was to assess the relationships between parenting, psychopathology, and daily-life social processes in adolescents. The findings presented in **Chapter 4** highlight how higher-quality parental bonding is associated with more positively experienced social interactions in the daily lives of adolescents, but not necessarily with more social behaviors in daily life. In a similar vein, we see in **Chapter 5** how greater general psychopathology levels relate mostly to the quality – and more inconsistently to the quantity – of daily-life social interactions. The most striking finding from Chapters 4 and 5 is the seemingly consistent relevance of the quality of social interactions for both parenting and psychopathology. In **Chapter 6**, we built on this finding in a comprehensive study where we assessed the different relationships between parenting dimensions, the quality of social interactions with different interaction partners, and general psychopathology levels. Parental responsiveness,

psychological control, and autonomy support all showed associations with the average experience of social interactions in daily life – with specific associations between certain parenting styles and the experience of social interactions with family versus non-family members. Of particular interest was the unique association between fathers' autonomy support and the experience of social interactions with non-family members. As social experiences with non-family members also had a unique association with general psychopathology level, the relationship between these three variables may be indicative of a mediation effect of parenting on psychopathology through altered social interactions in daily life.

For the second objective, we were interested in the momentary effects of online social interaction on affective well-being. The results presented in **Chapter 7** indicate how adolescents reported lower positive affect levels and higher negative affect and loneliness levels – but also, higher social interaction quality – when interacting online compared to when interacting face-to-face. At the same time, adolescents reported more PA when interacting online than when alone. No moderator effects could be found where those with different levels of social resources experienced different benefits/detriments from online interaction. These findings highlight how, in the moment of interaction, online social behavior may have benefits compared to being alone, but these potential benefits are likely smaller than those of face-to-face interaction.

Finally, in **Chapter 8**, we tackled the third objective of assessing the potential impact of the COVID-19 pandemic on adolescents' social lives and psychopathology levels. We found how, compared to the pre-pandemic situation, adolescents reported fewer face-to-face social interactions during the early stages of the pandemic, higher-quality face-to-face interactions, more online social interactions, but also, *lower* levels of psychopathology, and *lower* levels of anxiety than expected based on their age. Both the early stage of the pandemic when adolescents were assessed, and the increase in high-quality social interactions, may have contributed to this observed early resilience. Moreover, negative associations between the quality of face-to-face peer/family interactions and psychopathology levels became stronger during the pandemic, also potentially reflecting the increased importance of high-quality social interaction during a time of social deprivation.

9.3 Situating results in the field

9.3.1 An interaction between micro-level daily processes and macro-level development

Most relationships assessed within this PhD are not new. Ample research has

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already investigated socialization effects of parenting (Grusec, 2011; Smetana et al., 2015), or has established associations between certain parenting styles and psychopathology (Enns et al., 2002; Huppert et al., 2010). What is novel, however, is investigating these processes as they occur in *daily life*. By sampling from people's day-to-day contexts, we were able to observe relationships between different parenting styles and less positively experienced daily social interactions (Chapters 4, 6), and how these, in turn, may relate to the development of psychopathology (Chapters 5, 6).

The great value of assessing social processes in daily life has been argued more extensively in Chapter 3. In brief, day-to-day social processes are complex, dynamic, and context-dependent (Zaki & Ochsner, 2009), and to gain an accurate insight into any person's social life, an approach high in ecological validity is necessary. The need to focus on people's naturalistic environments to better understand their (social) development is also emphasized in a range of developmental theories, including ecological psychology (J. J. Gibson, 2014), the bioecological model (Bronfenbrenner et al., 2007), and developmental contextualism (Lerner, 1991). What these theoretical approaches have in common, is that they all emphasize how adolescent development cannot be understood apart from both its expression in day-to-day context, and its embedding in larger-scale environments. Within this PhD, experience sampling has provided a means to gain ecologically valid assessments of social processes, and to explicitly consider naturalistic contexts in our assessments.

By assessing in day-to-day life, the presented results provide some valuable real-life grounding for the investigation of the cross-level interaction between micro-level, day-to-day processes, and macro-level, long-term development. Dynamic systems models (e.g., Kunnen et al., 2019; Smith & Thelen, 2003; Van Geert & Lichtwarck-Aschoff, 2005) posit how development is shaped by dynamic processes interrelating at different time scales. Within this PhD, we have assessed this interrelation by focusing on the link between daily, seemingly mundane social interactions, and long-term socialization or psychopathological development. It has been previously established that parental autonomy support is associated with a range of adaptive outcomes in adolescence (Ryan et al., 2015; Soenens et al., 2007; Soenens & Vansteenkiste, 2005), but through the results presented in Chapter 6, we get a better sense of how the underlying developmental process may unfold in day-to-day social interactions. That is, paternal autonomy support was uniquely associated with how adolescents experienced social interactions with non-family members in daily life, which in turn, was associated with psychopathology level. Although the cross-sectional nature of these data preclude conclusions about mediation effects, these results do illustrate how the link between parenting and psychopathology may be expressed in day-to-day social interactions – or, how adaptive development

may unfold within the interaction between micro- and macro-level processes. As such, the results presented in this PhD provide informative input for further (longitudinal) investigations into the cross-level interaction between day-to-day behaviors and experiences, and long-term development.

In such subsequent longitudinal investigations, more specific consideration needs to be given to the question to what extent longer-term development may drive daily-life changes, vs. to what extent daily-life processes may drive longer-term development. Longitudinal models with data collected at both short and longer time intervals can be used to assess such questions (Meeus, 2018). For example, in one longitudinal assessment of adolescents, it was hypothesized that daily-life emotional variability mediates the long-term relationship between negative parent-child interactions and psychopathology (Maciejewski et al., 2014). What was found, however, was that daily emotional variability was not a mediator in this process, but a predictor of both negative parent-child interactions and psychopathology. What this illustrates, is that (1) longitudinal assessments are needed to disentangle how micro- and macro-level processes interrelate, and (2) that daily-life processes may be more drivers than consequences of longer-term development. Within the larger longitudinal SIGMA project, these questions can be investigated further for social processes in particular.

Although investigating the cross-level interaction between parenting, psychopathology and social processes is one of the most salient developmental processes, it is also but one of many developmental mechanisms worth considering. Different types of cross-level interactions between micro- and macro-level processes can be investigated using data from longitudinal studies that consider the daily-life level – such as the SIGMA project (Kirtley et al., 2021), the study from which the majority of the data presented here is drawn. Within the SIGMA project, we more broadly hypothesized how alterations in daily-life social interactions may mediate the relationship between all sorts of known risk and protective factors and the emergence of early psychopathology. For example, bullying, a lack of social support, exposure to trauma – all have been linked to the development of psychopathology (Brendgen, 2018; Dalgard et al., 1995; McKay et al., 2021), and all can be reasonably considered to affect mental health through initial expressions in day-to-day social processes. The interaction between day-to-day processes and longer-term changes is directly in line with the developmental theories describing a dynamic unfolding of (adolescent) development – and long-term ESM studies provide an excellent opportunity for further assessing these processes.

9.3.2 Quality over quantity

A principal result of this PhD project is that those adolescents with more negative

parenting perceptions – and those with greater levels of psychopathology – also experience their day-to-day social interactions more negatively. This emphasis on social experiences is largely consistent with the developmental literature on parenting effects, as different types of parenting have been explicitly linked to how children and adolescents make sense of their social worlds (Grusec & Davidov, 2021; Smetana et al., 2015). At the same time, however, successful socialization – a key goal of parenting – is also defined as the way in which individuals come to *behave* in accordance with the norms and rules of the society they live in (Grusec & Davidov, 2021). Consequently, successful socialization could be interpreted as an adolescent having friends, engaging in social activities, or entering in a romantic relationship. What the results in Chapters 4 and 6 indicate, however, is that parenting factors may relate less to these behavioral consequences of socialization, and more to experiential features of social interaction.

The emphasis on social qualities/experiences over social quantities/behaviors also has implications for our thinking about social dysfunction. The concept of social functioning – a key outcome in clinical settings – is largely defined by ‘objective’ characteristics similar to the described behavioral outcomes of successful socialization (Birchwood et al., 1990; Cornblatt et al., 2007). What our results demonstrate, however, is that an ‘ecologically valid’ type of social functioning – i.e., one that has solid grounding in day-to-life – may be defined more by altered social experiences than by altered social behaviors. This is in line with other arguments that a greater consideration of subjective factors is required in our conceptualization of social functioning – especially as objective and subjective factors tend to correlate weakly (Priebe, 2007).

In interpreting the findings of these altered daily-life social experiences and how they relate to certain person-level variables, an important caveat needs to be acknowledged. Although the experience-sampling assessments provide ecologically valid estimates of the variables that we are interested in, the observational rather than experimental nature of them makes it difficult to pinpoint exactly what drives our reported associations. Because day-to-day life is complex, and any daily-life measure is necessarily restricted, not every potentially relevant variable can be assessed – thus always leaving some level of uncertainty when interpreting experience-sampling findings. It should always be considered that different types of mechanisms may drive our observed data.

As a telling example, in the classic ESM work done by Csikszentmihalyi & Larson (Csikszentmihalyi & Larson, 1984), a puzzling finding was observed where those adolescents who generally reported having worse-quality relationships with their fathers also reported *lower* mean levels of negative affect when they were in the company of their fathers. Despite this finding being the opposite of what one might expect, a logical explanation for this finding does exist. When adolescents with a good paternal relationship had, for example, a

conflict with their father (and consequently reporting more negative affect when with dad), they might be more prone to still stay in the company of their fathers – as opposed to those with a worse paternal relationship who would be less likely to stay in their father’s presence when things are not going well.

The role of different reasons and motivations in explaining our findings should always be acknowledged when interpreting the studies presented in this PhD (or in all [social] ESM studies). In the studies presented in Chapter 4 and 6, we saw how adolescents with more positively perceived parenting generally also reported more positively experienced social interactions. It is likely that positive parenting generally makes people feel better when engaging in face-to-face social interactions, but it is equally possible that those with more positive parenting experiences also happen to be the people with a generally more supportive social environment – or that they are more willing or able to seeking out more rewarding social situations. A more active consideration of participants’ volition, context and motivation in daily-life studies is critical for understanding the processes that we observe in ESM studies (Kasanova et al., 2018).

One way of achieving more insights into these processes is by collecting more ESM data on participants’ reasons for their behaviors. Another helpful solution for learning more about what is happening differently in the daily lives of adolescents with differing levels of psychopathology is quite simple: Asking them. Qualitative work in which the social behaviors and experiences of different types of young people are assessed could prove invaluable in disentangling why it is that those young people with more psychiatric distress have more negative social experiences in their daily lives (Rich & Ginsburg, 1999).

Such qualitative work might have an additional focus as well. Given the limited validation work on ESM questionnaires, the confidence in whether these daily-life questionnaires capture the most relevant aspects of day-to-day (social) well-being of contemporary adolescents is fairly low. More insight into this can be gained by, for example, asking young people what they consider a fulfilling social life, what risk/protective factors they deem relevant, and whether this is captured by current instruments (González-Carrasco et al., 2019). Valuable qualitative work on ESM measures and interventions is already being done with clinical populations and therapists (Bos et al., 2019; Folkersma et al., 2021), but is adopted to a lesser extent for more fundamental research in non-clinical populations. Qualitative studies would be highly useful for further refining our methodological toolkit to validly measure those social and well-being outcomes that have the most relevance for contemporary adolescents.

9.3.3 Focusing on the individual

One of the major advantages of ESM-type data is that it allows for the

investigation of *within*-person processes. Although many studies in psychology aim to assess within-person processes (e.g., do people feel better when they are socially interacting?), a great deal of these studies actually investigate between-person differences (e.g., do people who generally have more social interactions feel better?) – which are fundamentally different research questions (Hamaker, 2012; Molenaar, 2004). In Chapter 7, we investigated the link between online communication and momentary well-being at the within-person level, thereby providing a unique answer to the relatively simple question: Do adolescents generally feel differently when they are interacting with others online vs. face-to-face? As it turns out, they do feel better in the moment that they are interacting face-to-face than in a moment of online interaction.

While this study has provided some unique insight about a contentious within-person relationship, it should be acknowledged that an even more individual approach is possible in investigating this relationship. By looking at the aggregated within-person effect of digital communication on momentary well-being (as we have done), an estimate is obtained of the average effect in the full sample. However, it is also possible to take an increasingly person-centric stance, where it is investigated what the within-person effect is *per individual*. For example, in a recent study by Beyens and colleagues (Beyens et al., 2020), it was found that 10% of adolescent participants felt worse after passive social media use, while 46% felt better, and for 44%, there was no effect. Within-person studies such as these truly acknowledge how certain effects may differ from one person to the next, and as such, it would be highly valuable to further incorporate such approaches in future studies as well.

An increasingly idiosyncratic approach might be valuable for the other foci of this PhD as well. For example, (Bülow et al., 2021) reported how the effect of parent-adolescent interaction quality on subsequent adolescent affect differs from family to family. Applying a similar approach would also be valuable to gain, for example, a better sense of how certain aspects of parenting (e.g., psychological control or autonomy support) can produce different outcomes in different children. Moreover, such individual approaches might be well suited for answering one of the most important questions in developmental psychopathology: Why do some children exposed to a certain risk factor develop psychiatric distress, whereas others, who have been exposed to the same risk factor, remain resilient? Perhaps the answer to this question (of what is also referred to as multifinality; (Cicchetti & Rogosch, 1996) can be found by focusing on the variety in pathological vs. adaptive responses that children or adolescents exhibit towards specific risk factors.

9.4 Methodological considerations

9.4.1 Strengths

The results of this PhD project should be interpreted in light of the strengths and limitations of the underlying methodology. At least four major sets of strengths contribute to the robustness, uniqueness, and added value of the presented findings. First, the sample sizes of both included studies (TwinssCan and SIGMA) are larger than most other ESM studies that we are aware of – allowing for an increased confidence in the accuracy of our findings. Second, in spite of the size of the studies, we still had a relatively extensive measurement protocol. For example, whereas many large-scale ESM studies have relatively limited assessments of, for example, momentary well-being or social interaction quality, our ESM questionnaires contained multiple items for each of these constructs. This has allowed for a more comprehensive conceptualization, but also for testing the within- and between person reliability of these constructs. Third, within the SIGMA study, we were unique in truly sampling adolescents' experiences throughout their entire week. To not disturb classes, most child and adolescent ESM studies only sample after school time, or during lunch breaks. In agreement with the schools, we did prompt participants with questionnaires during school time – thereby allowing for a truly representative view of adolescents' (social) lives, both in- and outside of the school. Fourth, we have strongly engaged in open science practices throughout all papers included in this PhD. We have registered extensive plans for most studies before looking at the data (and even developed a pre-registration template for ESM-type studies; (Kirtley, Lafit, et al., 2021), and we have shared all our materials and statistical code online. As such, we have aimed to be at the forefront of the newly evolving standards of transparency, reproducibility, and replicability.

9.4.2 Limitations

At the same time, a number of limitations also require consideration. First, compliance in the SIGMA sample was relatively low, around 40%, which is lower than in other, similar ESM studies (one review of youth ESM studies reported a mean compliance of 74%; (van Roekel et al., 2019). Despite the richness of the ESM data in terms of the extensive questionnaire and broad assessment period, this low compliance does restrict the representativeness of the data for adolescents' daily lives. It is plausible that missing data is not random, as adolescents might be more or less likely to fill out the ESM prompts when they are in certain (social) situations. Therefore, it would be valuable to investigate further in what moments participants tend to miss beeps. This could be accomplished

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through complementing studies with passive sensors or by asking participants about moments that they miss beeps in qualitative research. One recent study drew on data from passive sensors to learn more about missed prompts in an ESM study (J. Sun et al., 2021). Results of this study indicated few associations between environmental characteristics and non-compliance – indicating that the risk for structural missingness might be relatively low. Second, the follow-up rate of the SIGMA study during the COVID-19 pandemic has been low, with 173 out of 1913 of the original participants re-entering the study during the initial stages of lockdown. This follow-up sample was not representative, as participants were generally older and more likely to be girls compared to the larger sample. As such, the representativeness of the COVID-19 study for the whole population is more limited. Third, the validity of the included ESM items and questionnaires is still underdeveloped (Mestdagh & Dejonckheere, 2021; Wright & Zimmermann, 2019), which means, for example, that we do not have any ‘gold standards’ on how to assess general constructs like momentary affect or social interaction quality. More validation work in ESM research would be invaluable, and initial steps towards such work is being done within our center, for example, in the form of the ESM Item Repository (Kirtley et al., 2020).

9.5 Future paths

9.5.1 Social interactions in different socio-economic contexts

Within this PhD project, I have attempted to gain a glimpse of the social underpinnings of psychopathological development by largely focusing on the micro-level cosmos of the day-to-day social interaction. This is, however, not the only relevant social context. As prominently acknowledged in ecological and contextual models of human development (Bronfenbrenner, 1979; Lerner, 1991), human development takes place within multiple contextual levels, from the micro-level of social interaction to the macro-level of society. The relevance of this perspective is underscored by research that demonstrates how children and adolescents with a lower socioeconomic status (SES) background have a much greater risk of developing any mental disorder (Reiss, 2013). At the same time, most studies strongly undersample adolescents from low-SES backgrounds (Fakkel et al., 2020), thereby limiting our understanding of those adolescents who are at an increased risk. As such, there is a strong need for future research to also strongly consider the wider socio-economic context that adolescents find themselves in, and as such, to investigate how different micro-level social and macro-level societal processes interrelate to produce individual well-being.

This broader approach is particularly relevant in our continued study of the effects of the COVID-19 pandemic and its associated restrictions on adolescent

mental health. As the pandemic has entailed long-term social deprivation, a psychological cost is expected (Orben et al., 2020). While we observed resilience among adolescents during the early stages of lockdown in Chapter 8 of this PhD, the latest available studies (as of September 2021) indicate a deterioration of mental health for some young people throughout the pandemic – particularly for those with fewer social resources (Creswell et al., 2021). This deterioration may be particularly strong for the underrepresented group of adolescents from low-SES backgrounds, as economic inequality and mental health continue to be inextricably linked throughout the pandemic (Creswell et al., 2021; B. Gibson et al., 2021). Therefore, it is particularly important to specifically include vulnerable samples in the studies that we carry out in the years to come.

9.5.2 SIGMA-X: A step in the right direction

To address the challenge of learning more about those youth who are most at risk, we have developed a new project for which funding has been secured: SIGMA-X. At the time of writing, we are setting up this study complementary to the larger SIGMA project. SIGMA-X is composed of two major parts: (1) a newly recruited sample of $n = 120$ adolescents from socio-economically deprived backgrounds, who will complete similar measures as included in the larger SIGMA sample; and (2) a series of $n = 8$ youth advisory panels, in which we will engage in the groundbreaking act of talking to young people.

By following a new sample of at-risk young people, we will be able to estimate to what extent the COVID-19 pandemic has had an increased mid- to long-term effect on their social lives and mental health. Comparing this group to the larger SIGMA sample allows us to assess the different risk and resilience factors that may play a particular role for those from socio-economically disadvantaged backgrounds. For example, for those adolescents who have had no or limited means to follow classes remotely or to stay in touch with peers, do the prolonged lockdown measures have a lasting effect on their social development and mental health? Have the economic consequences of the pandemic had a stronger effect on the mental health of these youth? Are their specific resilience factors that might play a more important role in the different communities and contexts that adolescents find themselves in? By combining a multi-sample approach with an (intensive) longitudinal design, we will be able to tackle these and more important questions.

The youth advisory panels have two key aims. First, to hear from young people about their views on (social) well- and ill-being, about how they experience (ESM) research, and to what extent the risk and resilience factors and well-being outcomes that they deem most important align with the research that we do. Second, within the panels, we will discuss how various aspects of our studies

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can be improved: how to boost recruitment, how to reach those who are difficult to reach from underrepresented populations, but also, how to best communicate and disseminate our research findings back to young people. Then, by using the panels' suggestions to complement our existing studies, the voices of young people directly impact the quality and relevance of our research.

9.5.3 Suggestions for clinical implementation

The results of this PhD also have several important clinical implications – mostly for mobile health (mHealth) applications, also referred to as ecological momentary interventions (EMIs). While assessing people in their day-to-day lives can improve our understanding of daily-life processes through fundamental research (as is done in this PhD), it can also be employed to improve clinical interventions. Within an EMI, ESM-type sampling is used to help client and clinician in gaining insight into daily-life processes, or to directly deliver intervention elements in daily life (Heron & Smyth, 2010; Myin-Germeys et al., 2016b). Such interventions have largely proven possible and feasible (Pramana et al., 2014; van Aubel et al., 2020), with both patients and clinicians recognizing their potential usefulness (Bos et al., 2019).

In the design of EMIs, it needs to be considered that treatment goals may need to be adapted to the daily-life context. Notably, when aiming to improve social functioning in daily life (Hanssen et al., 2020) – we need to have some information on what good social functioning in daily life looks like. The results of this PhD shed some light on this issue. In defining social EMI treatment outcomes, at least three things need to be considered. First, the results of Chapters 4 to 6 indicate that any amount of social behaviors may not necessarily reflect good social functioning – the differential experience of social interactions seems more important and relevant. Second, despite alarmist accounts of the potentially devastating effects of digital technology on adolescent well-being, online social interactions should not necessarily be seen as maladaptive, as they may fulfil (young) people's social need to some extent. At the same time, they are unlikely to replace valuable face-to-face interactions. As demonstrated in Chapter 7, adolescents generally feel best when engaging in face-to-face interactions, but also, they feel more positive emotions when interacting online vs. face-to-face. Still, individual and contextual variability might exist here, as different adolescents likely experience different benefits/downsides from different types of online behavior. This relates to the third point: idiographic approaches emphasize that people respond differently to different situations – implying that people might benefit from individualized rather than fully standardized interventions. Additional daily-life research can shed more light on what works for whom in momentary interventions.

The findings presented here also have some potential implications for the

recently popularized concept of digital phenotyping. Digital phenotyping approaches suggest that human (mental) health can be reliably captured and predicted by seemingly arbitrary aspects of our behavior (T. R. Insel, 2017; Jain et al., 2015). For example, some studies have found how the content of Facebook posts can predict depression (Eichstaedt et al., 2018). Passive sensors on a mobile phone have the potential to collect an enormous amount of data of a person, such as their locations and movements, their online behavior and interactions with others, and various aspects of their speech. The promise of digital phenotyping research is that, given enough passively collected data and a sufficiently sophisticated algorithm, we will in the future be able to predict clinical outcomes with great accuracy. I am somewhat skeptical towards this promise. Our results indicated how the aspects of social interactions that are more relevant for mental health are in people's experience of them, rather than in their observable, countable aspects. This means that the best way to assess how people feel, is by asking them how they feel. In assessing mental health outcomes, the 'ground truth' is always experience-based, and as such, the most relevant predictors are most likely also grounded in experience.

9.6 Conclusions

The aim of this thesis was to investigate a fundamental developmental process: How adolescents' day-to-day social lives interrelate with different types of parenting and with psychopathology. We found how it is largely the experiential quality of daily social interactions that is associated with both parenting and psychopathology. Moreover, during the COVID-19 pandemic, the association between the quality of face-to-face social interactions with close others and mental health actually increased – which might be one reason why many adolescents appeared to remain resilient during the early stages of lockdown. Online social interactions do not appear to be particularly beneficial or deleterious for momentary well-being, although it should be further investigated how individual processes may differ.

Additional longitudinal research is required to further establish the link between adolescent socialization and mental health outcomes, and as such, to learn more about how developmental processes are manifested at the micro-level of day-to-day social interaction. In doing so, we gain the knowledge required to develop interventions that target the most proximal level of daily life.

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Supplemental materials

Chapter 4

Supplemental Material 1: Factor Analyses on all PBI items from TwinssCan dataset

Various previous studies have cast doubt on the original two-factor structure of the PBI (Parker et al., 1979), and instead, have proposed that a three-factor structure is more appropriate (Murphy et al., 1997; Xu et al., 2018). Therefore, we also aimed to test the factor structure of the PBI in our sample of $n = 635$ adolescent twins and their siblings for the manuscript “Be(com)ing social: Daily-life social interactions and parental bonding”.

The PBI consists of 25 items pertaining to the maternal relationship, and the same 25 items pertaining to the paternal relationship. Twelve out of 25 items are defined as part of a ‘Care’ subscale, and the remaining 13 items belong to the ‘Control’ subscale.

Confirmatory Factor Analysis (CFA)

First, we performed two CFA’s using the R-package ‘lavaan’, to test the original factor structure. All items loaded on their respective PBI subscales of Care and Control, separately for mother and father. These CFA’s resulted in models with suboptimal fit (fit statistics for mother: CFI = .82, TLI = .80, RMSEA = .084, SRMR = .083; for father: CFI = .81, TLI = .79, RMSEA = .085, SRMR = .080), where the 2 factors correlated highly: -.82 for both the maternal and paternal CFA. Subsequently, we decided to perform an EFA on both the mother and father scales.

Exploratory Factor Analysis (EFA): training set (60%)

EFA’s were performed in R using the ‘psych’-package, on a random 60% ($n = 381$) of the dataset. This subsample was used as a training data set, before confirming the found factor structure here in a test data set.

First, we performed parallel analyses with a polychoric correlation structure (following the ordinal scales of the items) to determine the appropriate number of factors. Since the parallel analysis with a polychoric correlation structure on the paternal items produced an error, we therefore proceeded without the polychoric correlation structure (i.e., assuming continuous rather than ordinal variables). Screeplots and eigenvalues suggested a three-factor solution for both maternal and paternal PBI items (see Figures 1 and 2 below).

Figure 1: Screeplot following parallel analysis with polychoric correlations for maternal PBI items

Figure 2: Screeplot following parallel analysis without polychoric correlations for paternal PBI items

Subsequently, we performed separate EFA's for the mother and father scales, with maximum likelihood and oblimin rotation, extracting three factors both times. The results of these analyses are displayed in Table 1, and correlations between the factors are given in Tables 2 and 3.

Generally, the found three-factor structure is consistent with earlier studies on the PBI (Cox et al., 2000; Cubis et al., 1989; Kendler, 1996; Kullberg et al., 2020; Murphy et al., 1997; Xu et al., 2018). Most items load on a 'Care' factor, similar to the care factor of the original subscale. However, items 4, 14, and 16 from the

original care subscale did not load strongly on the new care factor, and conversely, items 3, 7 and 8 from the original Control subscale loaded mostly onto the new Care factor. Then, the original Control subscale is now split up into two factors, with one factor characterized by items on denial of psychological autonomy, and another factor characterized by items of encouragement of behavioral freedom.

Consequently, we created three new subscales, based on the three obtained factors in the current study. Following (Murphy et al., 1997), items were included in a subscale if factor loadings were $>.3$ for both the maternal and the paternal scales. Item 25 does not have factor loadings $>.3$ on any factor for both parents so is omitted from the subsequent analyses. The obtained subscale structure was then tested in the remaining 40% of the sample.

Table 1: Factor loadings resulting from EFA on all maternal (M) and paternal (F) Parental Bonding Instrument (PBI) items. All factor loadings $< .2$ are omitted.

Item	Factor 1: Care		Factor 2: Denial of psychological autonomy		Factor 3: Encouragement of behavioral freedom	
	M	F	M	F	M	F
6. Was affectionate to me*	.80	.77				
12. Frequently smiled at me*	.80	.75				
1. Spoke to me with a warm and friendly voice*	.76	.74				
5. Appeared to understand my problems and worries*	.78	.74				
18. <i>Did not talk with me very much*</i>	.77	.69				
17. Could make me feel better when I was upset*	.72	.60				
2. <i>Did not help me as much as I needed*</i>	.71	.76				
11. Enjoyed talking things over with me*	.71	.69				
24. <i>Did not praise me*</i>	-.62	.53				
7. Liked me to make my own decisions	-.54	-.44			.25	.43
8. Did not want me to grow up	-.52	-.37				.35
3. Let me do those things I liked doing	-.42	-.50				
14. <i>Did not seem to understand what I needed or wanted*</i>	.38	.31	-.42	-.40		
16. <i>Made me feel I wasn't wanted*</i>	.27	.38	-.54	-.43		.21
20. Felt I could not look after myself unless she/he was around		-.21	.58	.58		
10. Invaded my privacy		-.25	.65	.56		
13. Tended to baby me			.60	.54		
9. Tried to control everything I did			.48	.66		
23. Was over-protective of me	.31	.29	.47	.57	.33	.31
19. Tried to make me dependent on him/her			.44	.53		
4. <i>Seemed emotionally cold to me*</i>			-.41	-.43	.20	
22. Let me go out as often as I wanted					.77	.69
21. Gave me as much freedom as I wanted	-.25				.67	.72
15. Let me decide things for myself	-.23	-.34			.38	.50
25. Let me dress in any way I please		-.21	.28		.28	.32

*Note: Items from original Care subscale are indicated with *: 1, 2, 4, 5, 6, 11, 12, 14, 16, 17, 18, 24; Items from original Control subscale: 3, 7, 8, 9, 10, 13, 15, 19, 20, 21, 22, 23, 25; All items in italics are reverse scored; all factor loadings in bold indicate that factor loadings are $>.3$ for that factor for both the maternal and paternal subscale (and are higher than other factor loadings). These items in bold were included for those subscales in the subsequent CFA that tested this factor structure.*

Table 2: Factor correlations following training EFA (mother)

	Factor 2 (Denial of psychological autonomy)	Factor 3 (Encouragement of behavioral freedom)
Factor 1 (Care)	-.48	.53
Factor 2 (Denial of psychological autonomy)		-.47

Table 3: Factor correlations following training EFA (father)

	Factor 2 (Denial of psychological autonomy)	Factor 3 (Encouragement of behavioral freedom)
Factor 1 (Care)	-.47	-.59
Factor 2 (Denial of psychological autonomy)		-.40

CFA: testing set (40% of sample)

Now, we assigned all items that loaded $>.30$ on a factor for both mother and father subscales to that factor, and tested this factor structure with a CFA using the R-package 'lavaan'. Fit statistics are adequate for the obtained models (maternal subscale: CFI = .86; TLI = .85; RMSEA = .074; SRMR = .085; paternal subscale: CFI = .89; TLI = .87; RMSEA = .068; SRMR = .074), and correlations between the factors are moderate to high (see Tables 4 and 5).

Table 4: Factor correlations following testing CFA (mother)

	Factor 2 (Denial of psychological autonomy)	Factor 3 (Encouragement of behavioral freedom)
Factor 1 (Care)	-.61	.63
Factor 2 (Denial of psychological autonomy)		-.64

Table 5: Factor correlations following testing CFA (father)

	Factor 2 (Denial of psychological autonomy)	Factor 3 (Encouragement of behavioral freedom)
Factor 1 (Care)	-.68	.58
Factor 2 (Denial of psychological autonomy)		-.42

Following these results, we decided to construct three subscales: Care (items 1, 2, 3, 5, 6, 7, 8, 11, 12, 17, 18, 24), Denial of Psychological Autonomy (items 4, 9, 10, 13, 14, 16, 19, 20, 23), and Encouragement of Behavioral Freedom (items 15, 21, 22). This was done by summing the Likert-scale responses (0-3) for each of their items, and dividing this by the number of items for each subscale. These subscale scores were subsequently used for all further analyses.

Chapter 5

Supplemental Material 1: Deviations from registration

Following the registration of Study 1, some of the registered methodological and analytic decisions were reconsidered. For transparency, we list the deviations from the registration here.

Since our focus is on youth, we decided to exclude all participants over 21 years of age ($n=115$, from Study 1 only). This was done following the registration, but prior to data analysis. Sensitivity analyses on the full sample contained no substantial differences with the reported analyses.

Some changes to variables were also made. For the psychopathology variables, we originally intended to use the depression and anxiety subscale of the SCL-90, in addition to a constructed psychoticism subscale. However, factor analysis showed that these subscales were insufficiently distinct, i.e., too highly correlated (see additional factor analysis in Supplemental Material available online for more details). Therefore, only the GSI score was included as a predictor in all subsequent analyses.

Also, as discussed in the registration for Study 1, we originally intended to include additional items for creating PA and NA scores (for PA: energetic; for NA: listless, down, and guilty), but since these items were only included in Study 1 and not in Study 2, for consistency we decided to compute PA and NA scores without these items. Inclusion of these additional items in creating affect scores did not substantially alter any of our results.

Supplemental Material 2: Factor Analysis to test the factor structure of the SCL-90

As discussed in the registration for this manuscript, we originally intended to extract three factors from the SCL-90: depression, anxiety, and schizotypy. The latter factor was not an original subscale, but was computed by combining the subscales 'Psychoticism' and 'Paranoid ideation'. Our decision rule was that if these factors correlated $< .80$ in Study 1, we would consider them separate subscales. However, correlations between these subscales were close to this cut-off value (.78 for depression-anxiety; .75 for anxiety-schizotypy), or at this cut-off value of .80 (for depression-schizotypy).

Therefore, we decided to further test the factor structure of these subscales in Study 1, by running a Confirmatory Factor Analysis (CFA) on these data. This was done in *RStudio* version 1.0.143 with the R-package 'lavaan'. The same items pertaining to the subscales 'Depression', 'Anxiety', and 'Schizotypy' were set to load onto these respective subscales. The R-code for this CFA was as follows:

```
library(lavaan)
fam1 <- 'Anxiety =~ scl90_2 + scl90_17 + scl90_23 +scl90_33
+scl90_39 + scl90_57 + scl90_72 + scl90_78 + scl90_80 + scl90_86
Depression =~ scl90_3 + scl90_5 + scl90_14 + scl90_15 + scl90_19 +
scl90_20 + scl90_22 + scl90_26 + scl90_29 + scl90_30 + scl90_31
+ scl90_32 + scl90_51 + scl90_54 + scl90_59 + scl90_79
Psychoticism =~ scl90_7 + scl90_8 + scl90_16 + scl90_18 +
scl90_35 + scl90_43 + scl90_62 + scl90_68 + scl90_76 + scl90_77
+ scl90_83 + scl90_83 + scl90_84 + scl90_85 + scl90_87 + scl90_88
+ scl90_90'

fit1 <- cfa(fam1, data=sclfa2)
```

Fit statistics for this model indicated generally insufficient fit: $X(816) = 3649.46, p < .001$; CFI = .81; TLI = .80; RMSEA = .068 (90% CI = .066 - .070). Moreover, the obtained factors correlated very highly: .91 (depression-anxiety); .92 (anxiety-schizotypy); .95 (depression-schizotypy). Since these high correlations indicate indistinguishable subscales, we decided to continue with a total score: The Global Severity Index (GSI), which represents the mean value across all items. Cronbach's alpha across the whole measure was .97, indicating high reliability.

Conceptualization of psychopathology

Thus, in Study 1, the symptom subscales that we originally intended to include correlated highly, and the results of a CFA showed even higher correlations between the depression, anxiety, and psychoticism factors. This indicated that the SCL-90 was unable to measure with any specificity the distinct psychopathologies that we aimed to measure. Although some studies have reported findings largely supporting the SCL-90(-R) factor structure (Arrindell & Ettema, 1981; Ryttilä-Manninen et al., 2016; Urbán et al., 2014), other authors have expressed validity concerns since the measure's inception (Cyr et al., 1985). Some recent studies using the Dutch version of this scale have noted that the depression subscale of the SCL-90-R reflects general psychopathology rather than specific depressive symptomatology (Arrindell et al., 2017; Hafkenscheid et al., 2009; Smits et al., 2015). Others have reported findings against the measurement invariance of the SCL, with different factor structures for different groups of people (Paap et al., 2012; Vassend & Skrandal, 1999).

Despite these critiques, the psychometric evaluations cited above do converge on one conclusion, namely that the SCL-90(-R) is a valid and reliable measure of general distress. The most recent latent modeling studies on the SCL-90(-R)

have reported relatively strong support for a model involving one general latent factor onto which all items loaded (Arrindell et al., 2017; Rytälä-Manninen et al., 2016; Urbán et al., 2014). This is in line with the recent proposition that a *p*-factor of psychopathology exists (Caspi et al., 2014). This *p*-factor has been conceptualized as a general liability for any type of psychopathology and is consequently independently linked to all psychiatric symptoms. Such a *p*-factor view does not dismiss the existence of diagnostic subtypes, but it does propose one general dimension that explains the variance in all psychopathology to some extent. Since the main aim of this paper was not to identify which specific factor structure fit the SCL-90 best in this dataset, we did not specifically analyze the bifactor structure that the *p*-factor implies. The aim was to have a reliable measure of psychopathology, and the general severity index that we used in this study does seem to reliably represent a broader liability for psychiatric problems.

Chapter 6

Supplemental Material 1: Transparent Changes to postregistration for 'Daily-life Social Experiences as a Mediator of the Relationship Between Parenting and Psychopathology in Adolescence'

This study was officially postregistered on the Open Science Framework on August 21st, 2019, with an addendum to the registration (detailing the exploratory mediation analysis) added on August 23rd, 2019. Both registrations are available through <https://bit.ly/3wH3LPE> and <https://bit.ly/2R9Cvsu>. In error, the original registration had previously been uploaded as a file to the OSF-page for this project on June 26th, 2019, instead of as a registration. This file upload occurred prior to data access and analysis. Data for this study were accessed on June 28th – thus, prior to the official registration, but following the initial upload of the registration to the OSF-page. Note that the original registration dated June 26th is the same as the official registration dated August 21st.

In this document, we transparently describe all changes that we made to our analysis plan following study registration, i.e. deviations from our original postregistration. All code relevant to this study is uploaded to the OSF-page of this project (<https://osf.io/vz4hy/>)

In the registration for this study, we originally planned to exclude participants from the study if they had completed fewer than 30% of all ESM questionnaires. This was based on common practice in many ESM studies and was first recommended ESM research guidelines from 1995 (Delespaul, 1995). However, the rationale for this 30%-exclusion rule has been subsequently questioned, as omitting participants from analyses might bias the results. (Jacobson, 2020). Therefore, for our main analysis, we decided to include all participants with valid ESM data, and to perform a sensitivity analysis applying the 30%-rule we originally specified.

In the analysis section of our registration, we described tests of whether paternal parenting styles predict only paternal social experiences, and whether maternal parenting styles predict only maternal social experiences (all as compared to non-family interaction experiences). Afterwards, we decided against this, and to test the interactions between each parenting variable and both the 'with mother' and 'with father' categories of the company variables. The reason for this was because, to assess the specificity of same-sex versus different-sex parent effects, associations with parents of both genders need to be considered in the analysis.

In the analysis section of our registration, we planned to conduct post-hoc Wald-type tests, to investigate whether the association between each parenting

style and social experience was significantly different when social experience pertained to a parent versus non-family members. However, these Wald-tests were unnecessary, as this difference in effects is directly tested with the included interaction effects.

In the registration, we noted that we would apply Simes' multiple comparison correction (Simes, 1986) to our confirmatory analysis results. However, we later realized this was inappropriate, as such a multiple comparison correction requires independent tests (which we do not have). Moreover, our confirmatory analysis involves multiple predictors that are all included in the same model, meaning they are already corrected, and do not require the strict multiple comparison correction that we had planned.

The addendum to the registration describes a mediation analysis, testing the indirect effects of parenting styles on psychopathology through altered social experiences. Based on later discussions within the team and among external researchers, we revisited the literature (Cole & Maxwell, 2003; Maxwell & Cole, 2007) and decided it was inappropriate to test for mediation effects using the cross-sectional data from the current study. . Therefore, for this mediation analysis, we made some changes, i.e. to only test the cross-sectional associations between all relevant variables that would be expected to be associated with each other following the mediation model. We used the 'lavaan'-package to test the full hypothesized path model with six predictors, three mediator variables, and one outcome, thereby obtaining the corrected coefficients for the direct effects. Indirect effects were not estimated in this comprehensive path model.

Chapter 8

Note: Supplemental Material 1 through 4 are all available online, on the OSF-page for this project: osf.io/rnu4s.

Supplemental Material 5: Correlations Between All T0 and T1 Predictors

Table 3: Correlations with confidence intervals between all T0 risk/protective factors, and T0 psychopathology

Variable	1	2	3	4	5	6	7
1. Trauma							
2. Social Skills	-.42**						
3. Bullied	.39**	-.20*					
4. Social Support	-.35**	.56**	-.19*				
5. Depression	.56**	-.44**	.44**	-.46**			
6. Anxiety	.53**	-.31**	.33**	-.39**	.72**		
7. Psychoticism	.65**	-.40**	.34**	-.43**	.85**	.79**	
8. GSI	.65**	-.42**	.41**	-.45**	.90**	.88**	.91**

Note. * indicates $p < .05$. ** indicates $p < .01$.

Table 4: Correlations with confidence intervals between all T1 risk/protective factors, and T1 psychopathology

Variable	1	2	3	4	5	6	7
1. Posttraumatic Growth							
2. COVID-related Stressors	.16*						
3. Social Support	.19*	-.05					
4. Resilience	.21**	-.19*	.70**				
5. Depression	-.02	.40**	-.36**	-.52**			
6. Anxiety	.06	.36**	-.23**	-.40**	.77**		
7. Psychoticism	.11	.37**	-.35**	-.48**	.84**	.74**	
8. GSI	.09	.43**	-.37**	-.52**	.91**	.88**	.89**

Note. * indicates $p < .05$. ** indicates $p < .01$.

Supplemental Material 6: Differences between subsample and larger SIGMA sample at T0

Table 4: Correlations with confidence intervals between all T1 risk/protective factors, and T1 psychopathology

Variables	T0 COVID sample (n = 173)			T0 non-COVID sample (n = 1740)			Statistical difference
	Mean (SD)	Median	Range	Mean (SD)	Median	Range	
Age	14.2 (1.8)	14.0	11.0 - 18.0	13.7 (1.9)	13.0	11.0 - 20.0	$t(df) = 3.02 (210.53), p = .003$
Gender (%girls)	88.4			60.7			$\chi^2(df) = 52.08(2), p < .001$
# of completed beeps (out of 60)	30.5 (12.7)	32.0	4.0 - 59.0	24.3 (12.6)	24.0	1.0 - 58.0	$t(df) = -1.80 (161.2), p = .074$
Interpersonal skills (VPV)	69.4 (7.5)	69.0	53.0 - 90.0	69.7 (7.7)	70.0	18.0 - 90.0	$t(df) = .43 (187.84), p = .67$
Social support (SSL-I-12)	22.8 (6.0)	23.0	5.0 - 36.0	23.0 (6.1)	23.0	0.0 - 36.0	$t(df) = .35 (199.44), p = .73$
Bullying	1.3 (1.3)	1.0	0.0 - 4.0	1.1 (1.3)	1.0	0.0 - 4.0	$t(df) = .68 (119.39), p = .50$
Trauma	6.3 (4.9)	5.0	0.0 - 19.0	6.7 (5.3)	6.0	0.0 - 33.0	$t(df) = -1.80 (161.2), p = .07$
Depression	1.0 (1.0)	0.7	0.0 - 3.5	0.8 (0.8)	0.5	0.0 - 4.0	$t(df) = -2.74 (180.04), p = .007$
Anxiety	1.0 (0.8)	0.8	0.0 - 3.3	0.9 (0.7)	0.7	0.0 - 4.0	$t(df) = -1.34 (184.23), p = .19$
Psychoticism	0.9 (0.8)	0.6	0.0 - 3.2	0.7 (0.7)	0.4	0.0 - 3.3	$t(df) = -2.73 (177.64), p = .007$
Psychopathology - total	1.0 (0.7)	0.9	0.0 - 3.4	0.9 (0.6)	0.7	0.0 - 3.4	$t(df) = -2.17 (180.06), p = .032$

Note. * indicates $p < .05$. ** indicates $p < .01$.

In Table 1, we see several differences between the sample that was followed up from Wave 1 (T0) to Wave COVID (T1), and the sample that was not followed up. Notably, older participants, girls, and those with higher depression, psychoticism, and general psychopathology were more likely to re-enter the study at T1. Because we had previously seen that age and sex are also related to psychopathology levels, we assessed the individual impact of age, sex, and psychopathology on the likelihood of re-entering the study at T1. Results of these logistic regression models (one for each psychopathology dimension) are presented in Table 2. What these results show, is that, after controlling for age and sex, those with more T0 psychopathology did not have greater chances anymore of participating again at T1.

Table 2: Logistic regression models predicting the likelihood of re-entering the Study at T1, from age, sex, and psychopathology levels.

Variables		T1 participation	
		β (SE)	<i>p</i>
T0	Age	1.37 (.24)	.031
	Sex	1.37 (.24)	<.001
	BSI depression	.12 (.10)	.22
T0	Age	.12 (.05)	.011
	Sex	1.41 (.24)	<.001
	BSI anxiety	-.01 (.12)	.92
T0	Age	.10 (.05)	.031
	Sex	1.37 (.24)	<.001
	BSI psychoticism	.19 (.11)	.09
T0	Age	.11 (.05)	.019
	Sex	1.39 (.24)	<.001
	BSI GSI	.08 (.13)	.53

p-values < .05 are highlighted in bold; BSI = Brief Symptom Inventory; GSI = General Severity Index

Supplemental Material 7: Analyses with COVID-19-stressor count score

Table: Linear regression model results, predicting total psychopathology (GSI) during the COVID-19 pandemic from a set of contemporaneous risk factors. Difference with Table 4 in full manuscript is that here, a COVID-19 stressors count score is used that is not weighted by the burdensomeness of each stressor.

		T1 GSI	
		β (SE)	<i>p</i>
T1	Resilience	-.02 (.00)	<.001
	Social support	-.00 (.00)	.47
	Posttraumatic growth	.01 (.00)	.09
	COVID-19 stressors (count score)	.09 (.02)	<.001

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Conflict of Interest Statement

The authors of all chapters of this manuscript (including the doctoral candidate) have no conflicts of interest to disclose.

Personal Contribution

I have not collected data for the TwinssCan project, which means that Chapters 4 and 5 involved secondary data analysis. I was partially involved in study conceptualization for the SIGMA study, and was a core member of the data collection team for SIGMA.

All empirical papers included in this dissertation were first-authored by myself, with the core supervision team (Olivia Kirtley, Maude Schneider, Inez Myin-Germeys) providing critical feedback on the initial drafts. Co-authors who had contributed to conceptualization of the TwinssCan project or data collection for the SIGMA projects provided feedback on later drafts of the respective manuscripts.

Below, I describe my and my co-authors' specific contributions to each individual chapter.

Chapter 3: Improving ecological validity in research on social cognition

All co-authors conceived and designed this book chapter. Having drafted an equal number of sections of this chapter, KSFMH and **RA** share first authorship. KSFMH drafted the parts pertaining to social cognition and ESM, while **RA** drafted the theoretical parts about ecological validity and about virtual reality. The introduction and conclusions sections were written by **RA** and KSFMH together. IMG, ZK, OJK, and MS critically reviewed and edited these sections, with MS largely supervising the writing process.

Chapter 4: Be(com)ing social: Daily-life social interactions and parental bonding

JD, CD, MDH, NJ, CML, BPFR, ET, JvO, MW, & RVW developed the overall study design for TwinssCan, and were involved in data collection. **RA**, IMG, and MS developed the concept for this study. **RA** performed data analysis, under the supervision of MW, and **RA** drafted the manuscript. OJK, IMG, and MS provided critical initial revisions of the draft. All other co-authors provided additional critical revisions, and approved the final version of the manuscript for submission.

Chapter 5: General psychopathology and its social correlates in the daily lives of youth

Similar to Chapter 4, JD, CD, MDH, NJ, CML, BPFR, ET, JvO, MW, & RVW developed the overall study design for TwinssCan, and were involved in data

collection. **RA**, OJK, IMG, and MS developed the concept for this study. **RA** performed data analysis and drafted the manuscript. OJK, IMG, and MS provided critical initial revisions of the draft. All other co-authors provided additional critical revisions, and approved the final version of the manuscript for submission.

Chapter 6: Daily-Life Social Experiences as a Potential Mediator of the Relationship Between Parenting and Psychopathology in Adolescence

RA, OJK, MS, and IMG were all involved in the conceptualization of this study; **RA** and GL designed the methodology; **RA** performed data analysis; **RA**, NH, KSFMH, APH, and AL were involved in data collection; **RA** wrote the original draft of the manuscript; OJK, MS, NH, KSFMH, APH, AL, GL, and IMG were all involved in subsequent review and editing of this manuscript; **RA** constructed the figures; OJK and IMG supervised the project leading to this research, with OJK managing and coordinating the research activity; and IMG acquired the funding for this research.

Chapter 7: Adolescents' Real-Time Social and Affective Experiences of Online and Face-to-Face Interactions

RA, OJK, MS, and IMG were all involved in the conceptualization of this study; **RA** and GL designed the methodology; **RA** performed data analysis; **RA**, NH, KSFMH, APH, and AL were involved in data collection; **RA** wrote the original draft of the manuscript; OJK, MS, NH, KSFMH, APH, AL, GL, and IMG were all involved in subsequent review and editing of this manuscript; **RA** constructed the figures; OJK and IMG supervised the project leading to this research, with OJK managing and coordinating the research activity; and IMG acquired the funding for this research.

Chapter 8: Changes in daily-life social processes and psychopathology symptoms in Flemish youth from before to during the COVID-19 pandemic

RA, OJK, and IMG were all involved in the conceptualization of this study; **RA** and GL designed the methodology; **RA** performed data analysis; **RA**, NH, KSFMH, APH, and AL were involved in data collection for T0 data collection; **RA**, NH, APH, EB & JJ were involved in T1 data collection; **RA** wrote the original draft of the manuscript; OJK, EB, NH, KSFMH, APH, JJ, AL, GL, and IMG were all involved in subsequent review and editing of this manuscript; **RA** constructed the figures; OJK and IMG supervised the project leading to this research, with

OJK managing and coordinating the research activity; and IMG acquired the funding for this research.

Professional Career

Robin Achterhof (Delfzijl, September 1st, 1992) hails from the town of Appingedam in the north of the Netherlands. With an increasing interest in what makes people tick, he started studying psychology at the University of Groningen in 2010. During the bachelor, Robin already became involved in psychological research through participation in the university's Honours College programme. At this time, he also followed several additional philosophy courses to think about the larger questions in life. In 2014, Robin obtained his Bachelor of Science in Psychology, with distinction. At this point, he was fully on the research train, and he started the Research Master Behavioral and Social Sciences in Groningen, focusing on clinical psychology.

During his master's programme, Robin developed a research interest in the psychological sequelae of traumatic events. He went on a three-month research stay to Christchurch, New Zealand, where he was supervised by Dr Martin Dorahy to study the effects of the 2010 earthquake that took place there. This research stay resulted in Robin's first publication, on posttraumatic growth. Back at home in Groningen, Robin worked with Dr Rafaele Huntjens, under whose supervision he wrote his master's thesis on the application of latent clustering techniques in validating Complex Posttraumatic Stress Disorder (published in 2019 at the European Journal of Psychotraumatology). In 2017, he graduated from his Master's programme.

Having developing an interest in using experience sampling to study mental health, Robin decided to apply for a PhD position with Prof Inez Myin-Germeys at the University of Leuven. In 2017, Robin started this position, where he then worked on setting up the SIGMA project – a large-scale longitudinal cohort focusing on adolescents' daily lives – under supervision of Dr Olivia Kirtley. Throughout his PhD, he developed an increasing professional interest in adolescents' social lives in relation to their mental health. Robin started writing papers about adolescents' daily social interactions, and how they relate to both their perceptions of parenting and to psychopathology, about the differential experience of face-to-face vs. online interactions, and about the impact of COVID-19 on adolescents' mental health and their social lives. This, in turn, resulted in the dissertation that lies before you. Throughout his PhD, Robin has enjoyed working with adolescents, giving talks in both academic and non-academic settings, and working on public outreach of research findings. Near the end of his PhD, he started coordinating the SIGMA-project, and funding was obtained from the King Baudoin foundation to further study the psychosocial effects of the COVID pandemic in a new cohort of at-risk youth. For the future, Robin is looking forward to further pursuing his research interests – and in doing so, to contribute to improving the lives of young people.

List of publications

All publications indicated with * below are included as chapters of this doctoral thesis.

Journal articles (peer reviewed)

- ***Achterhof, R.**, Schneider, M., Kirtley, O., Wampers, M., Decoster, J., Derom, C., de Hert, M., Guloksuz, S., Jacobs, N., Menne-Lothmann, C., Rutten, B., Thiery, E., van Os, J., van Winkel, R., Wichers, M., Myin-Germeys, I. (in press). Be(com)ing social: Daily-life social interactions and parental bonding. *Developmental Psychology*
- Achterhof, R.**, Kirtley, O. J., Schneider, M., Hagemann, N., Hermans, K. S. F. M., Hiekkaranta, A. P., Lecei, A., Lafit, G., & Myin-Germeys, I. (2022). Adolescents' real-time social and affective experiences of online and face-to-face interactions. *Computers in Human Behavior*, 12, 107159. <https://doi.org/10.1016/J.CHB.2021.107159>
- Vanherle, R., Kurten, S., **Achterhof, R.**, Germeys, I., Beullens, K. (2021). Stay Home, Drink at Home? A Daily Diary Study on College Students' Alcohol and Social Media Use During the COVID-19 Pandemic. *Substance Use & Misuse*. doi: 10.1080/10826084.2021.1990336
- Janssens, J.J., **Achterhof, R.**, Lafit, G., Bamps, E., Hagemann, N., Hiekkaranta, A.P., Hermans, K.S F M., Lecei, A., Myin-Germeys, I., Kirtley, O.J. (2021). The Impact of COVID-19 on Adolescents' Daily Lives: The Role of Parent-Child Relationship Quality. *Journal of Research On Adolescence*, 31 (3), 623-644. doi: 10.1111/jora.12657
- ***Achterhof, R.**, Kirtley, O.J., Schneider, M., Lafit, G., Hagemann, N., Hermans, K.S F M., Hiekkaranta, A.P., Lecei, A., Myin-Germeys, I. (2021). Daily-Life Social Experiences as a Potential Mediator of the Relationship Between Parenting and Psychopathology in Adolescence. *Frontiers In Psychiatry*, 12, Art.No. ARTN 697127. doi: 10.3389/fpsy.2021.697127
- Kirtley, O., Lafit, G., **Achterhof, R.**, Hiekkaranta, A., Germeys, I. (2021). Making the black box transparent: A template and tutorial for registration of studies using Experience-Sampling Methods. *Advances in Methods and Practices in Psychological Science*, 4 (1), 1-16. doi: 10.1177/2515245920924686 Open Access
- Achterhof, R.**, Huntjens, R.J C., Meewisse, M-L., Kiers, H.A L. (2019). Assessing the application of latent class and latent profile analysis for evaluating the construct validity of complex posttraumatic stress disorder: cautions and limitations. *European Journal Of Psychotraumatology*, 10 (1), 1-11. doi: 10.1080/20008198.2019.1698223 Open Access

Heins, M., **Achterhof, R.**, Collip, D., Viechtbauer, W., Kirtley, O., Gunther, N., van Os, J., Feron, F., Myin-Germeys, I. (2019). Social functioning and subclinical psychosis in adolescence: A longitudinal general adolescent population study. *Acta Psychiatrica Scandinavica*. doi: 10.1111/acps.13069 Open Access

Achterhof, R., Dorahy, M.J., Rowlands, A., Renouf, C., Britt, E., Carter, J.D. (2018). Predictors of Posttraumatic Growth 10-11 Months After a Fatal Earthquake. *Psychological Trauma-Theory Research Practice and Policy*, 10 (2), Art.No.10.1037/tra0000286, 208-215.

Journal articles (preprints, not peer reviewed)

Hagemann, N., Kirtley, O., Lafit, G., Wampers, M., **Achterhof, R.**, Hermans, K.S F M., Hiekkaranta, A.P., Lecei, A., vancampfort, D., Myin-Germeys, I. (2021). Objectively measured sleep duration, sleep quality, and symptoms of psychopathology in the SIGMA cohort. doi: 10.31234/osf.io/yx2eb Open Access

***Achterhof, R.**, Myin-Germeys, I., Bamps, E., Hagemann, N., Hermans, K.S F M., Hiekkaranta, A.P., Janssens, J., Lecei, A., Lafit, G., Kirtley, O. (2021). COVID-19-related changes in adolescents' daily-life social interactions and psychopathology symptoms. doi: 10.31234/osf.io/5nfp2 Open Access

Kirtley, O., **Achterhof, R.**, Hagemann, N., Hermans, K.S F M., Hiekkaranta, A.P., Lecei, A., Boets, B., Henquet, C., Kasanova, Z., Schneider, M., van Winkel, R., Reininghaus, U., Viechtbauer, W., Myin-Germeys, I. (2021). Initial cohort characteristics and protocol for SIGMA: An accelerated longitudinal study of environmental factors, inter- and intrapersonal processes, and mental health in adolescence. doi: 10.31234/osf.io/jp2fk

Hagemann, N., Kirtley, O., Lafit, G., Wampers, M., **Achterhof, R.**, Hermans, K.S F M., Hiekkaranta, A.P., Lecei, A., Vancampfort, D., Myin-Germeys, I. (2021). Objectively measured physical activity and symptoms of psychopathology in general population adolescents from the SIGMA cohort. doi: 10.31234/osf.io/43fcx Open Access

Hermans, K.S F M., Kirtley, O., Kasanova, Z., **Achterhof, R.**, Hagemann, N., Hiekkaranta, A.P., Lecei, A., Zapata-Fonseca, L., Lafit, G., Fossion, R., Froese, T., Myin-Germeys, I. (2021). Ecological and convergent validity of experimentally and dynamically assessed social capacity using the Perceptual Crossing Experiment in adolescence. doi: 10.31234/osf.io/jrzbw

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- ***Achterhof, R.**, Kirtley, O., Schneider, M., Hagemann, N., Hermans, K.S F M., Hiekkaranta, A.P., Lecei, A., Decoster, J., Derom, C., de Hert, M., Guloksuz, S., Jacobs, N., Menne-Lothmann, C., Rutten, B., Thiery, E., van Os, J., van Winkel, R., Wichers, M., Myin-Germeys, I. (2020). General psychopathology and its social correlates in the daily lives of youth. doi: 10.31234/osf.io/95afu
- Kirtley, O., Lafit, G., **Achterhof, R.**, Hiekkaranta, A.P., Myin-Germeys, I. (2019). Making the black box transparent: A template and tutorial for (pre-) registration of studies using Experience Sampling Methods (ESM). doi: 10.31234/osf.io/seyq7 Open Access

Book chapter

- *Hermans, K. †, **Achterhof, R.** †, Myin-Germeys, I., Kasanova, Z., Kirtley, O., Schneider, M. (2019). Improving ecological validity in research on social cognition. In: K.E. Lewandowski, A.A. Moustafa (Eds.), *Social Cognition in Psychosis*, Chapt. 10, (249-268). Academic Press. ISBN: 978-0-12-815315-4. doi: 10.1016/B978-0-12-815315-4.00010-0

† These authors contributed equally to the work.

Reports

- Kirtley, O., **Achterhof, R.**, Hiekkaranta, A., Hermans, K., Hagemann, N., Germeys, I. (2019). *Hoe word ik wie ik ben? De voorlopige resultaten van de SIGMA-studie.*
- Kirtley, O., **Achterhof, R.**, Bamps, E., Janssens, J., Hiekkaranta, A., Germeys, I. (2019). *Te Gek!? Onder de Loep.*

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Olivia – I know that compliments are not always entirely comfortable for someone as utterly British as yourself, so please brace yourself. I feel so incredibly lucky to have worked under the daily supervision of the absolute academic powerhouse that you are. Not only are you one of the smartest and hard-working people that I know, you have also always been so kind, considerate, and motivating². In our supervision meetings, I've always felt safe, listened to, and inspired. Thank you, Olivia.

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Karlijn, Inez quickly labeled you as my research spouse, and, despite my opposition to straight marriage, I couldn't help but develop a little professional

² And okay, perhaps a bit prudent...

crush on you. We quickly formed a great social contingency, and with your jovial Limburg nature, you immediately made me feel at home in this new country. Still now, I am so grateful to have you as a friend to go back to for any work-related quandary, personal issues, or just some juicy gossip. I am so happy to see you continuing in the same field, and I hope that we'll be able to work together some more.

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