Moving as one:

Agency and social unity in joint action and its breakdown

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Abstract

Joint action can take many forms: whereas rowers synchronise their movements, dancers often engage in closely coordinated complementary action. Even in martial arts, fighters closely coordinate their movements in an effort to understand and control their opponent's movements. In joint actions such as these, the possibilities for action require multiple agents to partake in the social system, as the joint action cannot be enacted by an individual alone. Although most people have an intuitive understanding of what it means to experience having an impact on one's environment, this paper is particularly concerned with providing a formal understanding of agency in a social system where control within the social system is distributed over multiple agents. The central question is: how do agents experience social unity in situations in which the individual actions cannot be understood separately from the behaviour of the system as a whole? In this paper, we combine insights from social and ecological psychology and behavioural dynamics to propose a theoretical framework on how joint action affects the experience of agency and social unity. Using empirical examples from rowing, dance and martial arts, we discuss how determining the link between psychological states during coordination and accidental or intentional breakdowns (in cooperative failure or combative success, respectively) provides insights into fundamental debates about the nature of joint action (Butterfill, 2012; Gilbert, 1996; 2000; Marsh, Johnston, Richardson, & Schmidt, 2009a; 2009b; Sebanz, & Knoblich, 2009a; 2009b).

Keywords: joint action, dynamical systems, agency, social unity, cooperation, combat.

Introduction

Coordinating our behaviour and joining in action with others is fundamental to human life. Starting out fully dependent on the (caring) actions of others at the beginning of life, we learn to adapt and coordinate our actions to the degree that it may become an art form, such as in dance or a synchronised kata¹ in karate. Take for example the task of moving furniture, such as a couch. Alone, one is not able to carry it up the stairs, but together, the task may be done. Yet, this requires fine coordination and constant mutual adaptation; an unexpected withdrawal of one agent may break down the coordination and result in a dropped couch. In joint actions such as these, the possibility for action requires a social system with multiple agents to join in, that is, the joint action cannot be enacted by an individual alone. Although all humans have an intuitive sense of what it means to experience having an impact on one's environment, this paper is particularly concerned with advancing a formal understanding of agency in a social system where control within the social system is distributed over multiple agents. More broadly this paper addresses how agents engaging in joint action experience being part of a social system.

The above-described example relates to a fundamental debate on agency and social unity, in which the relation between the two is often described as a zero-sum trade-off: an increase in social unity is typically seen as costly when it comes to protecting individual distinctiveness and agency, and people are therefore destined to balance their social and individual desires (e.g., Brewer, 1991; Codol, 1975; LeBon 1895; Zimbardo, 1969). Underlying these theories is the assumption that being part of a social system requires individuals to give up their individual agency, while breaking free of the uniformity of a group may open up room for individuality (Codol, 1975). One reason for this may be that much of the research on joint action has focused on synchronous action, in which individual actions may be less discernible, and individual possibilities for movement may be restricted to conforming to the collective. However, recent studies that have considered different forms of coordinated action, such as complementary action, do not support a zero-sum trade off view: instead, they suggest that the experience of agency and social unity may go hand in hand (e.g., Koudenburg et al., 2015).

¹ For an impression, see e.g. the finale of the 2014 World Karate Championships:
https://www.youtube.com/watch?v=Hbi_eNjeeMs&feature=youtu.be

In the present article, we propose a dynamic systems perspective on joint action, to explain how experiences of agency and social unity may relate within joint action. This perspective allows for a better interpretation of the findings for both synchronous and other, complementary forms of action. Moreover, it allows us to formulate predictions for how the experience of agency and social unity may evolve in action that is not cooperative, but rather combative in nature.

Considering joint action from a dynamical system perspective

A dynamical systems approach offers new insights on the relation between agency and social unity in joint action. If we take a look at joint action, e.g., as illustrated in the example of jointly carrying the couch upstairs, it becomes clear that a joint action can only be carried out by a social system consisting of multiple agents. An individual action of an individual agent is meaningless in this regard; trying to lift the couch alone will not result in the joint action of carrying the couch upstairs, unless another agent joins in and lifts the couch in correspondence to the first agent. This implies that the agents within the social system need to coordinate their actions, i.e., they need to mutually adapt their actions to the actions of the others in order to enact the possibility for joint action, such as carrying the couch upstairs. To take an example that lies close to the example of jointly carrying a couch upstairs, we may consider the example of Asch (1952, pp. 173-174), namely that of two boys carrying a log together (Figure 1).

Carrying a log *individually* requires organising oneself in such a way that the combined centre of mass (*CoM*) of both the log and oneself (forming one system) is maintained above one's centre of pressure (*CoP*). When doing so, one is able to feel one's muscles tensing to maintain the combined centre of mass within the region of pressure (maintaining balance) and to resist the force of the log moving towards the ground. The latter requires creating a counter force that can be felt as a flow of force moving through the body, from the feet to the hands carrying the log. Now, to carry a log *jointly* means that the system is extended from oneself and the log to include the other agent with whom one is carrying out the joint action, shifting both the centre of mass and the centre of pressure to include both agents and the log. As a result, an individual agent within that system not only needs to account for the forces created by oneself (and the passive force of the log moving to the ground), but for forces created by other agents in the system as well, which can be kinetically (i.e., in terms of force) felt through the log.

Coordination in joint action therefore requires mutual adaptation between the agents within the social system. In this example, the coordination should result in a balancing of forces within the social system, minimising perturbations that may throw the system off balance and make the discordances between one's actions and those of one's partner painfully clear.

Fig. 1 Jointly carrying a log. By forming a social system with someone else, the centre of mass of the system as a whole (Joint CoM), resulting from the CoM of both agents and the log, needs to be kept above the centre of pressure of the system (Joint CoP). They both resist the log from moving towards the ground by creating tension between hands and feet, guiding the Joint CoM towards the Joint CoP as indicated by the grey lines.

Although this may seem as if the collective action of the social system is made up of the individual actions of the individual agents combined, note that these individual actions are in turn facilitated or constrained by the collective action of the social system. This illustrates that in joint action, the collective action of the social system is not made up of the individual actions of the individual agents combined – but rather emerges from the interactions between the agents within the social system. This dynamical view posits (1) the emergence of the behaviour of the whole from the individual components, and 2) the constraint of that overall behaviour on the individual components (Juarrero, 1999; Kelso, 1995; Richardson et al., 2005). Such a system entails circularity; the behavior of the social system (e.g., carrying the couch upstairs) emerges from the actions of individual agents within that system and constrains the actions of the individual agents in return: only by coordinating their actions, the agents may be able to lift the couch upstairs and if one agent disengages and drops the couch halfway on the stairs, the other agents are clearly constrained in their ability to lift to lift the couch (or even worse, fall off the stairs).

Agency

Taking a dynamical perspective on (joint) action has consequences for the conceptualization of agency. Take for instance, the actions of two individuals moving a couch together in the previous example. For traditional cognitive science perspectives, given an action such as moving one's hand to grasp the couch, agency would be conceptualized in terms of either causal initiation of that action ("Did I move my hand myself?"), or in terms of causal contingencies between the action and a proximal outcome of the hand movement ("Is the rising of this end of the couch a consequence of *my* movements?"). For approaches focused on causal initiation, individual agency means something so immediate and embodied as answering yes to the question of whether *I* moved my own hand (Synofzik et al., 2013) or whether I felt I had conscious will in moving a hand (Wegner et al., 2004). For a causal contingency or attributional perspective on this action, agency equates to perceived control over potential consequences of moving one's hand. Perceiving that one has control means that one believes that one has behaviours that one is capable of enacting that increase the likelihood of getting a desired outcome such as getting the end of the couch raised above a stair. Typical recent research on agency has participants do an action such as move a joystick in order to try to control some

proximal outcome (e.g., control a cursor on a display), and agency is assessed as the degree to which participants believed the cursor movement was contingent on their own joystick movement (Dewey et al., 2014). Decades of older research on contingency and perceived control establishes that individuals generally have a strong bias to perceive events as personally controllable, but that a variety of variables strengthen such perceptions even for noncontingent outcomes (Anderson, 1991; Anderson & Deuser, 1993; Langer, 1975, 1983; Rothbaum et al., 1982; Thompson, 1981; Wortman, 1976). For instance, both the frequency of acting and the desirability of received outcomes increases perceptions of control or agency. Research also provides compelling evidence that having perceiving control over outcomes is highly beneficial for future performance and for healthy functioning (Anderson & Riger, 1991; Averill, 1973; Dweck, 1975; Glass & Singer, 1972; Miller, 1979; Rothbaum et al., 1982; Skinner, 1985; Taylor & Brown, 1988; Thompson, 1981). However, this earlier era of causal attribution research focused solely on how individuals interpret actions within a solitary context, not within a context of joint action.

Some understanding of how individuals interpret outcomes when two people are co-acting comes out of theorizing about internally-generated explanatory processes. In contrast to an attributional perspective, these approaches to agency focus on internal prediction and sensorimotor comparator processes, not verbalized judgmental processes. These approaches follow from models of motor control, in which issuing a "motor signal" initiates internal sensorimotor representations that predict what should follow from this command, and if the resulting motoric behaviour matches the predictions (the mentally simulated movement), then one believes one was the agent of that movement (Frith et al., 2000, Blakemore, 2000; Blakemore et al., 2002). Research testing whether a sensory prediction approach explains individuals' experiences of agency during joint action suggests that sensory prediction effects alone cannot fully explain experiences of agency when dyads are jointly controlling an outcome using complementary actions (Experiment 2, Dewey et al., 2014): attributional processes are also necessary.

In sum, traditional cognitive-oriented approaches to agency view it as a consequence of some combination of an internal prediction process and/or an externally verbalized, conscious inferential process. In these processes, contingencies between what occurs and what was expected, intended, or desired are assessed and weighed to calculate one's degree of agency.

This means that people can partition perceived degree of causality of an outcome into judgments about how much oneself or one's cooperating partner caused the event, or other potential factors such as random chance. In contrast, a dynamical systems approach takes a decidedly less mechanistic view in which control is simply not decomposable into separate components. Instead, Gibson (1979) notes:

“Locomotion and manipulation are neither triggered nor commanded but *controlled*. They are constrained, guided, or steered, and only in this sense are they ruled or governed. And they are controlled not by the brain but by information, that is, by seeing oneself in the world. **Control lies in the animal-environment system.** Control is by the animal *in* its world, the animal itself having subsystems for perceiving the environment and concurrently for getting about in it and manipulating it.” (p. 215).

From this view, for joint action contexts one would recognize that other people are an important part of humans' **environment** but also, that a social system can be viewed as an emergent organism (akin to an "**animal**") in the animal-environment system. Understanding how control can be understood to reside at the level of the animal embedded in the environment requires unpacking Gibson's concept of affordances: the possibilities for action that an environment provides an animal with certain capabilities. The log in Figure 1 affords grasping with one's hands for humans because humans have hands of a certain size and strength and features such as opposable thumbs, but graspability is not a feature that resides *in* the log - it would not afford grasping for birds or dogs. The log may also afford partially lifting for an individual, provided the individual has sufficient strength and postural control, but it might not afford one alone to fully lift it off of the ground. The log also affords a social system grasping, lifting and moving it, provided the social system has appropriate strength, mobility, and coordination skill. As these examples illustrate, affordances are inherently a relational property, that is, one that can only be defined with reference to both an environment and an actor. Research on solo action such as whether risers of certain heights afford climbing, or which pieces of wood will be lifted with one or with two hands find that affordances are precisely predicted by quantifying aspects of the environment relative to aspects of the animal: leg length

relative to stair height for stair climbing (Warren, 1984) or hand size relative to object size for grasping, for instance (van der Kamp et al., 1998). Affordances for solo versus joint actions (e.g., moving large objects alone or together) have been found to be similarly predicted by quantifying fit between actors' capabilities and object dimensions (Richardson et al., 2007). Furthermore, note that in a social system, the environmental constraints are not restricted to the mere physical environment (e.g., can one jump high enough to duck the ball in the basket), but extends to the sociocultural environment as well - scoring points in basketball is also constrained by the rules of the game (Heft, 2007; Meagher, 2020; Rietveld & Kiverstein, 2014; Van Dijk & Withagen, 2016; Van Dijk & Rietveld, 2017). In the case of a culture where a potential log-lifter is required to wear clothes that inhibit action (or perception), or is not permitted to move in certain ways or to cooperate with individuals of certain gender or social category, it would constrain the possibilities for how and if a log could be cooperatively moved.

Thus, we return to the question: how is agency presumably experienced when one views action as occurring in a social system conceived as a distributed dynamical system? In joint action the control emerges from the interactions between multiple agents and the environment, instead of being decomposable into individual agents. The actions of one individual who is lifting an end of the log is continually changing the affordances for the other individual while acting. In sum, the actions and perceptions of the other agent opens up new possibilities for the other to act, and closes down other avenues of action as well, with these affordances changing continually during the time course of an event. This means that an individual engaging in joint action can experience both *joint agency*², brought about by the effects that joint actions are perceived to bring about in the environment, as well as *individual agency*, the perception that one's own actions bring about change in the environment. While we expect individual and joint agency to be interrelated, the nature of their relationship - as involving some degree of tension between individual *versus* joint agency - or as synergistic, with one intensifying the other - is likely to depend on the type of joint action performed by the actors.

² Although it may be expected that individual experiences of the agents within a social system share large similarities (e.g., experiencing the same situation, jointly bringing about the same effect), the experience of joint agency may differ from the experiences of the other agents in the system – e.g., as one is only able to kinaesthetically perceive their own actions (Sheets-Johnstone, 2011).

Social unity

As various studies have shown, engaging in joint action may bring about associated feelings of social unity (Lickel et al., 2000; Koudenburg et al., 2015; 2017; Wiltermuth, 2012; Bernieri, 1988; Miles et al., 2009). Such experiences of social unity include both the psychological sense of oneness (or entitativity: the perception of unity of the group as an entity) that is derived from interdependencies between individuals (e.g., Campbell, 1958; Durkheim, 1893/1984; Lickel et al., 2000), and the cognitive and emotional experience of belonging to a certain group (Leach et al., 2008). How are these feelings of social unity brought about? That is, how do agents engaging in joint action experience being part of a social system?

As the possibilities for action are constrained by the joint actions of the social system as a whole, an important precursor for feelings of social unity to be brought about by joint action may lay in the experience of the correspondence between one's own actions and the actions of the other agents within the social system. When enacting an affordance, an animal interacts with and adapts to the environment. It has, so to say, a response-ability to (changes in) the environment, answering to the world around him (Ingold, 2017). In joint action, this response-ability becomes a shared one. In other words, the agents within the social system need to *co-respond* (or correspond) to changes in the environment, requiring them to coordinate their actions (Ingold, 2017):

“It is the process by which beings or things quite literally co-respond or answer to one another over time, as for example the exchange of letters or words in conversation... For it is in attending to one another, as they go along together, that beings correspond” (p. 26).

Research on synchronous joint action suggests that such correspondence of actions may bring about an experience of ‘moving as one’ and feelings of social unity. Correspondence of actions is also required in other forms of joint action, albeit in a different form of coordination. How does this relate to feelings of social unity, that are often found by engaging in synchronous joint action?

Breakdowns in coordination

For a wide range of joint actions, coordination is not effortless, but involves skills that require practice. For a rowing crew, it may take many years to reach perfect synchronisation, to have explored the dynamics of the coordinative system as a whole to such a degree that they can account for perturbations such as hitting a wave or a flash of strong wind, perfectly adapting to changes in the environment (Cuijpers, 2019). In the beginnings of developing such skill, far more often perturbations may affect coordination negatively, resulting in small deviations from coordination that may lead to larger and larger deviations and eventually a breakdown in coordination. However, once we master skills, coordination can become more or less the standard. In conversations, for instance, people are often so well-versed at coordinating their speaking turns into a smoothly flowing conversation, that any disruption of this flow is experienced as a breakdown of coordination. Such breakdowns provide important information about the experiences we are interested in in this paper. Namely, when coordination runs smoothly, there is often little reason to reflect upon one's experience of agency or social unity. However, it is when coordination breaks down, for instance, when a silence falls in a conversation that was until that point characterized by a smooth turn-taking, that people start reflecting on the quality of relationships (e.g., Koudenburg et al., 2011; 2017). In other words, breakdowns alert people to possible problems in the social system, that they previously took for granted. For that reason, studying the psychological experiences of agents when different forms of coordination break down provides unique insights into understanding how joint action may affect experiences of unity and agency.

Synchronous joint action

Moving in synchrony is often touted as the ultimate form of joint action and the case of crew rowing provides a good illustration of our ability to synchronise (e.g., Cuijpers, 2019; De Poel et al., 2016; Marsh et al., 2009). Watching a boat of eight rowers moving in unison on the water, coordinating their movements to perfect synchronisation, one sees one boat, one crew, rather than the eight individual athletes as they pass by. It is an impressive sight: the degree to which eight individuals can coordinate their movements jointly, attuning to one another at all times, accounting for perturbations from the environment such as the blade hitting a wave or a flash of wind (Cuijpers, 2019). As we, spectators, see the crew as one unit, how do the athletes within the crew experience being part of that unit? How do they experience their own and partners' endeavours to move the boat jointly through the water?

As the possibilities for joint action exist only by virtue of the social system, it is implied that the possibilities for one's (individual) action are constrained and facilitated by the actions of others in the social system. The example of the rowers pushing off collectively against the boat to set it in motion illustrates how each individual rower's action is constrained by the force their crewmembers exert onto their blades, with which they propel the boat forward to a certain speed (Cuijpers et al., 2019). As the pressure on the blade is created by the difference between the velocity of the blade with respect to the velocity of the boat (be it in opposite direction), the velocity of the individual movement (or stroke rate in rowing terms) needs to correspond with the velocity of the boat (Figure 2; Cuijpers et al., 2017; Hill & Fahrig, 2009). This entails that the action of an individual rower can be facilitated by the actions of their crewmembers when the movements of the rowers are corresponding with one another (i.e., allowing the rowers to transfer their power most effectively into boat speed), enabling joint action. Alternatively, an individual rower may be perturbed, for instance when one suddenly finds a much higher pressure against the blade as their crewmembers' blades did not catch the water yet (resulting is a less optimal transfer of power into boat velocity), threatening not only social unity, but individual and joint agency as well. Indeed, when rowing well-coordinated, "the boat feels light" as indicated by one of the rowers interviewed in the study of Millar et al. (2013). When rowers are moving in perfect synchronisation, the perception of one's own movement may perfectly correspond with the effects that the movements of the others have on one's own movement. Such perfect

correspondence of actions between crewmembers can lead actors to experience social unity.

Fig. 2 Relation between pressure on the blade(s) and propulsion of the boat. The collective forces applied onto the blades propel the boat forward at a certain velocity. If the forces applied onto the blades suddenly lower (see the left tree upper blades in panel b compared to panel a), the fourth upper rower on the right side experiences a much higher pressure on the blade and thus higher resistance to maintain the same velocity of moving the blade through the water – which is required to maintain in sync with the rest of the crew.

Indeed, a large body of literature demonstrates that acting in synchrony together with others leads to social bonding, (generalized) pro-sociality, and cooperation (Fischer et al., 2013; Good & Russo, 2016; McNeill, 1995; Reddish et al., 2014; Valdesolo & Desteno, 2011; Wiltermuth & Heath, 2009). This can be observed in a broad area of synchronous behaviours, such as line-dancing, choral singing, soldiers marching, and collective rituals, and they all have in common that movements are matched in time and expression, and aggregates of individuals consequently experience, and are perceived, as more united (Ip, Chiu, & Wan, 2006; Lakens, 2010; Miles, Nind, & Macrae, 2009). Research shows that synchronous interaction increases not only group entitativity (e.g., Bernieri & Rosenthal, 1991; Cappella, 1996; LaFrance, 1982) but also interpersonal liking (the strength of interpersonal relations within the group) and cooperative behaviour (Lakens, 2010; Marsh, Richardson & Schmidt, 2009, Fischer et al., 2013; Hove & Risen, 2009; Valdesolo & DeSteno, 2011).

By joining in synchronous action, a sense of community and commitment among actors increases, while individual differences or contributions shift to the background. Indeed,

synchronous movement has been shown to blur self-other boundaries: even complete strangers perceived themselves as more similar to each other and showed more conformity to each other after synchronous, rather than a-synchronous coordination (Miles et al., 2010; Paladino et al., 2010; Wiltermuth, 2012). This suggests that the strong correspondence and similarity in actions may enhance the experience of joint agency, while limiting the experience of individual agency. When one's individual contributions are not unique, a lesser contribution of one of the agents (while preserving the quality of coordination in terms of timing) may have less severe consequences. Even if one rower produces less force, this does not need to perturb the other crewmembers in their movements, and the boat may still move through the water, albeit a little slower than before. Moreover, the joint commitment to act as one crew toward the goal (Gilbert, 1996; 2000) means that others are obligated to compensate if one individual has to reduce their effort, which is less possible if each agent offers a unique contribution to the joint action. In line with this perspective, research on the coordination of speech, dance, and musical performances demonstrates that synchrony reduces one's sense of individual agency compared to other forms of coordinated action (Koudenburg et al., 2015; Van Mourik Broekman et al., 2018; 2019).

Note however that the experience of joint and individual agency can also reinforce one another – especially in synchronous action such as rowing. When rowers are moving perfectly in synchronisation, the perception of one's own movement may perfectly concord with the effects that the movements of the others have on one's own movement. In such moments, even the smallest perturbations from the movements of the others fall silent, leaving only the perception of one's own action, while at the same time the effects of ones' action may be amplified by the contribution of the others. As a consequence, one may experience one's own movements and the amplified effects thereof in terms of boat velocity (Millar, 2013), which may feel extremely agentic.

This rapidly shifts when the quality of coordination decreases, possibly resulting in coordination breaking down. If one crewmember deviates abruptly from the synchronised coordination (such as when their blade is pulled under water, called 'catching a crab'), two things could happen. If the deviation does not upset the balance of the boat too much, the other crewmembers may be able to continue their synchronised coordination and the actions of the rower catching a crab become very salient to the crew. Alternatively, the blockage of the blade under water may hinder the crew to such a degree that the boat turns sideways and the other

crewmembers are so perturbed in their movements that coordination breaks down altogether. Similarly, one could consider less extreme deviations that start to resonate throughout the system, pushing and pulling members to synchronise with the timing of one and then the other, until coordination breaks down altogether (Cuijpers et al., 2015).

In both scenarios, the correspondence of actions that may bring about the experience of social unity is compromised. This is particularly clear in the latter examples, where coordination breaks down altogether. In the first example however, this may be more complex, as the majority of the crew continues to unite their actions, while one rower fails to fulfil his or her commitment to the social unit. From the perspective of Gilbert (2000), the deviant's joint commitment obliges them to try their best to achieve the group's goal; ending this obligation requires at least tacit acknowledgement of this by others. As such, in the case of a crewmember failing to uphold their obligation to move in sync, others are "thus entitled to rebuke the other for failure to fulfil this obligation" (Gilbert, 1996, p. 184). This way, the experience of social unity can be maintained, but the deviant is no longer part of this social unit.

In terms of agency, in both scenarios the experience of joint agency is reduced, yet in the first example the consequences for individual agency are somewhat more complex. On the one hand, when coordination breaks down altogether, the experience of individual agency breaks down as well, as the breakdown in coordination perturbs the possibilities for actions within the social system to such a degree that they cease to exist. On the other hand, the experience of individual agency may increase when one is no longer part of the social unit, as deviating from the synchrony opens up many action possibilities, that were previously restricted to a single behaviour that was similar to those of the other actors. As such, actors should become more individually agentic in determining their own actions.

Complementary joint action

Despite synchronous action often being described as the archetypical example of joint action, in many, if not most, cooperative joint actions individuals behave in a complementary, rather than uniform fashion (e.g., a conversation, or dance)³. Whereas rowers synchronise their movements, dancers move differently, yet in close coordination, attuned to each other and the music. This close coordination is especially important in partnering, where both dancers form a joint structure, for instance during a lift. By doing so, dancers create affordances for their partners, which is even more risky in sports like cheer: a flyer (athlete who performs the acrobatics in the air) would not be able to twist and turn so high up in the air, without support from her base (the athlete supporting from the ground) to accelerate the jump up in the air and land safely⁴. In a daunting ‘toss to hands’⁵ (a stunt in cheer) the base accelerates the flyers jump up into the air, catching the feet so that the flyer can stand upright in the air on the base’s hands that are held at the base’s shoulder height. In other words, although each agent offers an individual contribution to the joint action, those actions enable each other (the flyer would not be able to fly so high up in the air if the jump upwards would not be accelerated by the throw or the base, nor would the base be able to hold the flyer up in the air if the flyer wouldn’t fixate the posture by tensing the muscles). The experience of social unity in this regard is more related to the degree to which the actions of one complements the actions of the others, rather than actions being similar to the actions of the others during synchronous joint action. In contrast to synchronous joint action, in which the individual actions only stand out when they are failing the intended goal, in

³ One may even argue that in the synchronous example of crew rowing, complementary actions are required in terms of force; in a pair (two rowers handling one oar and thus one side of the boat each), the stroke rower needs to produce relative more force during the first half of the stroke and the bow rower during the second part of the stroke to make the boat run straight and maintain synchrony in terms of the angle of the oar (Baudouin & Hawkins, 2004; Kleshnev, 2016). Similarly, in order for orchestra musicians playing different instruments to play the same note at the same time, they must initiate different patterns of movement—bowing, blowing, pressing, and striking at different times. Synchronous *movement* such as postural sway between musicians or musicians and listeners particularly serves to entrain aesthetic *experiences* of the music (Demos & Chaffin, 2018).

⁴ for an impression, see the Netflix documentary “Cheer”:

<https://www.youtube.com/watch?v=dhXRxlva18>.

⁵ For an explanation of a ‘toss of hands’, see <https://www.youtube.com/watch?v=xXdiNGtH5cE>.

complementary joint action each individual offers a unique contribution, which is a much more salient commitment to the common goal.

Even though individual actions may differ, agents can still experience the degree to which their actions correspond to one another. Indeed, engaging in complementary action also induces experiences of social unity (Koudenburg et al., 2015; 2017). One of the clearest examples of highly skilled complementary coordination is an everyday conversation. People are very well-versed at the turn-taking process, and sensitive to signalling when another person's turn is coming to an end and it's their turn to take over (e.g., Goodwin & Heritage, 1990; Sacks, Schegloff, & Jefferson, 1974). Studies on the failure to coordinate speaking turns (e.g., when silences occur, or delays in computer-mediated-communication) show that this has severe consequences for the experience of social unity: people feel their relationships are threatened (Koudenburg et al., 2011; 2013; 2017; Pearson et al., 2008). In other words, complementary actions are strongly interdependent, with large consequences once coordination fails.

Research on singing and dancing demonstrates that beyond inducing social unity, complementary action also leads to an increased sense of *individual* agency among actors⁶ (Koudenburg et al., 2015; Van Mourik Broekman et al., 2018). In fact, their experience of individual agency is related to their experience of unity: the actors' unique role in a joint endeavour is what makes the group successful. This implies that in terms of the experience of individual agency, it may be more salient for the agents within the group what each individual's contribution is to the achievement of the joint action, more so than in synchronous action.

In complementary action, as in synchronous action, the individual actions are not possible in and of itself and can therefore not be viewed separately from the actions of others. With a lesser contribution of one of the agents the coordination of the system is therefore likely to break down. Even more so than in synchronous joint action, precisely because the contributions of each individual cannot be replaced by the other agents within the system: the individual actions are so dependent on actions of others that any breakdowns in the system ceases the possibility for any

⁶ Please note that in the referred papers, the authors use the term “personal value to the group” rather than individual agency. The concept however is very similar to what we define as individual agency: the extent to which an individual experiences that they play a part in the functioning of the group. In fact, the three items that measure the concept in these studies are very much in line with this idea: “I had an important role in this group”, “I think I was indispensable to this group”, “Without me, this group would not function”.

individual actions to exist. This may be best demonstrated by the findings from experiments on dance performances (Van Mourik Broekman et al., 2019). In a set of field experiments, the researchers manipulated whether dancers coordinated their actions (in more synchronous or more complementary ways), or whether dancers engaged in individualized action: each dancer performed their own solo on stage, without making any sustained contact with other dancers. Though one could argue that this might be perceived as a highly agentic situation – the dancers could independently decide how to act – the findings suggested quite the opposite: the audience perceived dancers as less individually agentic than when they engaged in complementary coordinated action (no differences were found with the synchronous action condition). By extension, this suggests that when actions are not grounded in a joint action, the impact one can have on one's environment and other actors is reduced, leading to a reduced experience of individual agency.

Combative joint action

In combative joint action, agents still need to coordinate their actions, but now in an aim to limit the possibilities for action for the opposing agent. In contrast to cooperative forms of joint action described above, the agents in a combative joint action do not share the same intention, but are rather opposed to each other in a fight over individual agency. Interestingly though, the possibilities for action remain to exist within the joint action; one cannot submit the other when the other is out of reach. Here too, affordances are not merely constrained by the physical environment, but the social environment as well. In a Mixed Martial Arts fight, the agents share a joint commitment to have a competitive match. They are jointly obligated therefore to follow certain rules of the game, and they are obligated to continue the match until one wins or the game ends (e.g., time is up; Gilbert, 1996; 2000). Such social constraints are not limited to a competitive match, but apply to combative behaviour more broadly. Also in real confrontations, actions have (social) meaning and consequences that may limit or invite certain behaviours. As an example, where a dominance display (posturing, loud vocalisation) may deter a psychopathic attacker, this same behaviour can and often does escalate conflicts motivated by status. In the same vein, a fight over status may be resolved by showing submissive behaviour (holding one's hands up, walking away); whereas showing the same submissive behaviour may be actually encourage more violent action in predatory behaviour, such as in a psychopath trying to lure a victim to a more remote location without witnesses (see e.g., De Becker, 1997; Miller, 2011).

The tension between the need to coordinate actions in order to limit the opportunities for action for their opponent, has interesting implications for the experience of agency and social unity. For it is only by sustaining coordination that an agent has the opportunity to affect and possibly control their opponent's possibilities for action. One form of martial arts that seems particularly fitting to illustrate these ideas, is the Russian martial art Systema. More specifically the Kadochnikov Systema, further developed by prof. Kadochnikov (a mechanics professor at the Technical University of Krasnodar, Russia) is a combative system based on biomechanical principles to move as efficient and effectively as possible, using movements of the opponent to one's own advantage. By exploring the biomechanical principles in different situations rather than practicing choreographed techniques, one develops a more intuitive ability to adapt to

whatever the situation may bring. By forming one biomechanical system with one's opponent, one is able to exert a flow of force throughout the whole system, thereby moving the opponent to preferably a less advantageous position. One of the exercises that may illuminate this is the pushing hands game, in which two agents stand facing each other with their hand in front touching each other (Figure 3). The aim is to maintain the contact through the hands and to imbalance the opponent so that they need to take a step (backward or forward) to remain their upright position. The most apparent strategy here is to push forward, pushing the opponent's centre of mass outside of their centre of pressure, so that they need to take a step to bring their centre of mass within their centre of pressure again. However, in order to push one's opponents centre of mass behind the opponent's centre of pressure, one needs to bring one's own centre of mass forward too. In other words, one becomes dependent on the resistance of the opponent's hands pushing back to maintain one's own balance and if the opponent suddenly drops this resistance, moving their hands towards themselves, one may lose one's own balance falling forward and needing to take a step forward to prevent that.

Fig. 3 Dynamics of the pushing hands game. By pushing forward in an aim to move the CoM of the agent on the right outside of their CoP, the CoM of the agent on the left moves forward as well. Now, balance of the agent on the left is dependent on the agent on the right resisting; a sudden let go of this resistance may accelerate the CoM of the left agent forward, leaving the left agent no other option than to take a step to regain balance.

The above example illustrates that in order to be able to perceive and affect the (opportunities for) actions of the opponent, one needs to form one coordinative system with the opponent and remain in close coordination with the opponent. The perceptions that especially

matter pertain to the body organisation (constraining or facilitating certain actions) of the opponent. By forming a biomechanical system one is able to kinetically perceive the flow of force throughout the opponent's body which can then be used to turn their force against them. This is difficult to infer from say, vision alone, as a certain body position can be achieved by different ways of organising the body (e.g., slightly more weight on the left than on the right foot, which allows the opponent to take a step with the right and not with the left foot). Note that fighters make use of this too, practicing the maximisation of impact force while minimising the amplitude of their movements and using angles that make it more difficult to see a strike coming. The importance of coordination in martial arts was underlined by the finding that more experienced martial artists are able to account for deviations in timing introduced by adding weights to their arms, maintaining the correct timing in coordination with their opponent, whereas novice martial artists were perturbed by the weights and deviated in the timing of their actions in correspondence to the actions of their opponents (Caron et al., 2017).

Interestingly, in combative joint action a breakdown in coordination may actually open up new possibilities for action. A moment of losing attention for example, may provide an opportunity for one's opponent to take the lead and decide where the social system will move towards (which is generally a disadvantaged position for the actor who has no other option than to follow). In line with the example of the pushing hands game, an agent may use its attacker's action against them, e.g., by moving away from a strike while catching the attackers arm and pulling it further along towards the ground. The force initiated by the strike has to go somewhere and now that it is not absorbed by the attacked and even accelerated forward, the attacker has no means to maintain balance and has no other possibilities that to move towards the ground. In other words, the attacker is pulled into a trajectory that predetermines their loss - all other degrees of freedom have been increasingly narrowed down. As both agents closely account for each other's attacks, a delicate balance and a symmetry of forces is preserved, while they strive to break that symmetry within the system (Krabben, Orth, & van der Kamp, 2019) in a competition for agency. The extent to which they are successful in enforcing their course of action on their opponent affects their experienced individual agency, which may increase when one is dominating the opponent, and abruptly vanish as one is forced to submit. Similar battles of power have been observed in the joint action of a conversation (Clark, 1996), when one speaker is attempting to steal the floor from another speaker, for instance by means of interrupting

another speaker, or more subtly, by not accommodating to another's persons speaking behaviours (Giles, 2016; Koudenburg et al., 2014; 2017). While such interruptions and non-accommodation are likely to momentarily disrupt the flow of a conversation, they are intended to enforce a new social order, in which the person who was interrupted has no other choice than to listen to the person they are interrupted by.

Note that agents engaging in combative joint action may still experience a high correspondence of actions, as a high quality of coordination is required to create possibilities for action. Moreover, even when the symmetry is broken and if one has a complete lack of agency, one can still experience a high correspondence of actions. One can be surrendered to the system one takes part in, being left with just one option which is move to where the opponent intends one to go. An example of this is a well-executed throw in Judo, where one is thrown so efficiently that one may wonder what just happened as one lays on the ground. Although the experience of the correspondence of actions may be high throughout this entire sequence, associated feelings of social unity (e.g., entitativity, belongingness, and liking) that we find in cooperative joint action are likely to be minimal.

Conclusions

The assumption that group behaviour leads to a restriction of individual agency is widespread in both lay and scientific theorizing (e.g., Codol, 1975; Zimbardo, 1969). Indeed, the ultimate example of uniform behaviour, synchrony, has been associated with lower individual agency compared to more complementary forms of action (Van Mourik Broekman et al., 2018; 2019), and has even been suggested to result in aggressive obedience (Wiltermuth, 2012). This paper suggests that, when drawing conclusions about the effects of synchrony on the experience of agency, one should also consider the alternative to synchrony: what if all coordination breaks down, or what if people behave as mere individuals, with no response to one another whatsoever? The studies reviewed in this paper suggest that in a situation where people have committed to engage in joint action (to cooperate or to compete), displaying such highly independent behaviour would not be associated with people feeling individually agentic at all (Koudenburg et al., 2015; Van Mourik Broekman et al., 2019). In fact, in instances where coordination between individuals fails so dramatically, the experience of individual agency is especially likely to be compromised. It appears as if people derive their possibilities of action (and with that, their sense of agency) from the social system that they are engaged in.

In the present article, we propose a novel theoretical framework for how joint action affects the experience of agency and social unity. While the relation between the two is often assumed to be a zero-sum trade-off in which an increase in agency often comes at the cost of social unity and vice versa, we showed that considering joint action from a dynamical systems and ecological psychology perspective may offer new insights on this relation. Considering joint action as emerging from the interactions within the social system and in which affordances for joint action are constrained by the social and physical environment, has implications for viewing the experience of agency and unity in joint action. Enacting affordances in joint action requires coordination among the agents within the social system, which is an emergent property as the actions of agents are facilitated and perturbed by the actions of other agents within the social system. To understand the relation between agency and unity, we emphasise the importance of considering alternative forms of joint action to synchrony, as for different forms of joint action, the experience of agency and unity is affected differently, especially when coordination breaks down. These are summarized in Table 1.

Agency and social unity in joint action

Table 1. Overview of the experience of agency and social unity in various forms of joint action.

Joint action	Coordination + / breakdown -	Agency	Social Unity
Synchronised	+	(-) Constraining actions to be similar among actors may limit actors' experience of individual agency, yet: (+) Strong correspondence between perception of one's own actions and 'amplified' effects thereof by the joint actions. (individual agency is contingent upon joint agency).	(+) Similarity in the perception of actions may result in blurring of self-other boundaries, increasing experience of social unity
	-	(-) Joint agency decreases as: 1) Actions of the system as a whole become less effective, or; 2) The possibility for joint action ceases altogether. (+) Individual agency may increase: individual action opportunities may increase due to the release of one's obligations to the group.	Deviations between actions may result in: (-) Salient discrepancy between actions of individual agent and the rest of the social system, leading to exclusion of agent from the system, or: (-) Amplification throughout the system, breaking down coordination altogether, resulting in decreased social unity.
Complementary	+	(+) Clear individual contribution(s) increase experience of individual agency. (+) Spill-over effect from joint agency: one's actions enable a social system which affects the environment.	(+) Actions complement each other, each agent has a unique contribution. Social unity is high.
	-	(-) Individual agency is reduced, as one is no longer able to affect other agents or the environment.	(-) Social unity is threatened.
Combative	+	Individual agency is not shared but competed for in the social system through breakdowns in symmetry. High for the agent dominating and low for the agent submitting to the social system.	(-) Correspondence of actions is not experienced as a social unity, with respective feelings of belonging and identification.
	-	(-) A breakdown in coordination ceases the agents' control over the system and experience of individual agency. (+) momentary breakdowns may create opportunities to take over individual agency within the social system.	(-) No correspondence of actions, no experience of social unity.

Note. In column 2, + refers to situations where coordination is successful and a minus sign (-) reflects situations where breakdowns are occurring. In the other columns, + or - signifies the direction of the correlation between coordination/breakdown and feelings of agency or unity.

In synchronous joint action the correspondence of actions is grounded in the similarity of actions. When coordinating well, discrepancies between one's own actions and the actions of the others may vanish, resulting in a blurring of self-other boundaries and a strong experience of social unity. In complementary joint action, the correspondence of actions is grounded in the complementarity of distinct individual actions. Here, correspondence of actions is also likely to induce a sense of social unity, based on the successful combination of individual actions in a social system.

Synchronous action may compromise an individual's experience of agency, because one's individual action possibilities are restricted to behaving in synchrony. On contrast, in complementary joint action, the individual agents have more possibilities for action, provided that they closely coordinate with others in the system. As the individual contributions in complementary action are more distinct, individual agency is likely to be increased in complementary action compared to synchronous action. That said, individual agency can also be amplified through the experience of joint agency: a strong experienced correspondence between one's actions and the effect thereof in the environment, amplified by the actions of the other agents within the social system. These experiences may occur for both synchronous and complementary joint action, although the experience is likely to be somewhat stronger when moving in synchrony.

By reviewing research on breakdowns in different forms of coordination we gained specific insights in the relation between individual- and joint agency and social unity. In both forms of cooperative joint action, breakdowns in coordination threatened social unity. The consequences of breakdowns for individual agency, were, however, distinct for the different forms of joint action. In both synchronous and complementary action, stable breakdowns may lead to a reduction in the experience of joint agency, because coordination is necessary to reach joint goals. This is tied to the experience of individual agency, which decreases because individual actions are constrained by the collective actions, and thus coordination of the social system. In synchronous action, however, a breakdown may also correspond with a slight increase in individual agency, as the individual scope for action possibilities increases.

In contrast to the two forms of cooperative joint action described above, in combative joint action agents within the system hold opposed intentions (i.e., to submit the other agent within the system). This means that the experience of agency of each agent is inversely related to

that of the other. Interestingly, striving for agency within the social system requires the agents to closely coordinate their actions. Although this correspondence of actions is required to affect and control the opponent, it is not expected to bring about an experience of social unity. Similar to cooperative joint action, when coordination breaks down, the possibilities for action cease to exist, as does the experience of agency. However, a momentary instability of coordination may provide an opportunity to break the symmetry in the system, and take over the upper hand. The experience of agency depends on the extent to which an actor is able to control the other actors' movements to correspond to their own.

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