Validation of the Self-Report Version of the German Strengths and Weaknesses of ADHD
Symptoms and Normal Behavior Scale (SWAN-DE-SB)

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Data and analyses:

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Abstract

Adults diagnosed with attention-deficit/hyperactivity disorder (ADHD) experience impairing levels of inattention and/or hyperactivity-impulsivity (APA, 2013). However, symptoms are also prevalent in individuals without ADHD, following a continuum continuously distributed across the general population (e.g., Coghill & Sonuga-Barke, 2012). Yet, ADHD self-report scales so far hardly aimed to capture these continuous distributions. Additionally, they largely focused on individuals' weaknesses and ignored strengths. To address these shortcomings, we here present the SWAN-DE-SB, a self-report version of the German version of the SWAN (Strengths and Weaknesses of ADHD-Symptoms and Normal-Behavior [SWAN] Scale; Schulz-Zhecheva et al., 2019; Swanson et al., 2012), for use with adults. The scale's normality, internal consistency, and factorial and convergent validity were assessed using data from a general population sample of 398 adults (287 female, 109 male, 2 diverse), eleven of them with diagnosed ADHD (i.e., 2.5%; Song et al., 2021). Its clinical utility was evaluated by comparing scores of individuals without ADHD and a clinical sample of 49 adults diagnosed with ADHD (19 female, 28 male, 1 diverse, 1 unknown), and by computing optimal cut-off values for specificity and sensitivity. Information on the participants' ethnicity was not obtained. The findings demonstrated the SWAN-DE-SB's normality, high internal consistency, and factorial and convergent validity. It further reliably discriminated participants with and without ADHD, with high specificity and sensitivity. The SWAN-DE-SB should thus be considered to have excellent psychometric properties to assess strengths and weaknesses of ADHD symptoms and normal behavior in clinical and general population samples.

Key words: SWAN scale, Attention-Deficit/Hyperactivity Disorder (ADHD), self-regulation, self-report, adults

Preprint

Public Significance Statement

So far, questionnaires assessing inattention, hyperactivity, and impulsivity, which are also referred to as key symptoms of attention-deficit/hyperactivity disorder (ADHD), largely focused on individuals' weaknesses and ignored strengths. Additionally, they had not been designed to assess ADHD symptoms in the general population, in which they are continuously distributed. To address these shortcomings, we developed the SWAN-DE-SB and show here that this questionnaire is suitable to assess strengths and weaknesses of ADHD symptoms and normal behavior in the general population and for diagnostic purposes in clinical settings.

Adults with symptoms of attention-deficit/hyperactivity disorder (ADHD; American Psychiatric Association, 2013) experience symptoms of either inattention (e.g., difficulty sustaining attention at work, during tasks or activities), hyperactivity-impulsivity (e.g., interrupting and intruding on others by butting into conversations, excessive talking), or both. These symptoms were shown to implicate impaired academic (e.g., lower rate of high school and university degrees), occupational (e.g., lower overall income), and social functioning (e.g., fewer friends, higher divorce rates; Frazier, Youngstrom, Glutting, et al., 2007; Fredriksen et al., 2014; Friedman et al., 2003; Mannuzza et al., 1997). ADHD is classified as a neurodevelopmental disorder and symptoms are expected to initially manifest in childhood. However, symptoms were shown to persist into adulthood in about half of the cases, resulting in a prevalence of approximately 2.5% in adults (Simon et al., 2009; Song et al., 2021).

Prior studies, however, clearly demonstrated that not only individuals diagnosed with ADHD experience inattention and hyperactivity-impulsivity. Instead, the symptoms should be considered to reflect a continuum reaching from no or very low (i.e., subthreshold) to very intense and clinically significant symptomatology (Frazier, Youngstrom, & Naugle, 2007; Haslam et al., 2006; Levy et al., 1997; Marcus & Barry, 2011; Salum et al., 2014). Relatively asymptomatic individuals can thus be assumed to experience intensities representing the positive extreme (i.e., functionality), while patients with ADHD can be assumed to experience symptom intensities representing the negative extreme (i.e., dysfunctionality) of a continuum distributed across the general population.

Despite these findings, common clinical ADHD rating scales almost exclusively depict a deficit-oriented view, thereby solely focusing on individuals' weaknesses and ignoring potential strengths, whereby they artificially truncate the full range of behaviors (Swanson et al., 2012). This approach could result in major methodological difficulties, especially when assessing ADHD symptoms in non-clinical samples (cf. Schulz-Zhecheva et

al., 2019; Swanson et al., 2012). First, as the majority of the general population presents with no or only rarely occurring ADHD symptoms and only few individuals anchor at the negative extreme of existing clinical scales, any such scale typically produces a skewed distribution. Such distributions cause severe methodological ramifications in studies viewing ADHD symptoms to be continuously distributed in the general population as, by overlooking meaningful variance at the positive end of the distribution, statistical power and validity is substantially reduced. Second, scales only focusing on individual deficits overlook strengths that would allow to compensate for weaknesses (e.g., being organized despite difficulties in staying focused when working on a task), which should result in low construct validity.

To overcome these shortcomings, Swanson and colleagues (2012) introduced the *Strengths and Weaknesses of ADHD-Symptoms and Normal-Behavior (SWAN) Scale* assessing symptoms of school-aged children's inattention and hyperactivity-impulsivity through third-party report. This scale comprised 18 items and is based on the symptom criteria outlined in the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (DSM-IV; American Psychiatric Association [APA] 2000, also in accordance with DSM-5, APA, 2013). The SWAN scale was designed to assess school-aged children's symptoms, wherefore the items' wording addresses school and play situations and children's behavior at home. Contrasting the wording of established clinical scales, all items were worded positively (e.g., "Remembers daily activities" instead of "Is often forgetful in daily activities"). A 7-point scale anchoring the negative (i.e., "far below average") and positive (i.e., "far above average") ends of the dimension was used to compare the child with other children the same age. The original SWAN scale therefore comprised the first scale assessing ADHD symptoms in a truly dimensional way. Like its later translations to Spanish, French, Chinese, and German, it was shown to have excellent psychometric properties as reflected in normally distributed data in the general population, high internal consistency and adequate

retest reliability, a consistent factor structure, and excellent convergent validity as indicated by high correlations with existing diagnostic instruments (Arnett et al., 2013; Hay et al., 2007; Lakes et al., 2012; Polderman et al., 2007; Schulz-Zhecheva et al., 2019; Swanson et al., 2012). Additionally, its sensitivity and specificity in distinguishing children with and without ADHD as well as children with ADHD and other mental disorders have been shown (Chan et al., 2014; Lai et al., 2013; Robaey et al., 2007; Schulz-Zhecheva et al., 2019).

Nevertheless, neither the original SWAN scale nor any of its translations so far were designed for use with adults. First, their items' wordings referred to schoolchildren's activities and environments, so they were not applicable to adult life. Additionally, a self-report version was not available so far, although self-reports are one of the most important sources of information in adulthood. An ADHD rating scale capturing the continuous distribution of symptoms in the general adult population is therefore highly warranted.

The Present Investigation

We therefore adapted the existing German SWAN-DE (Schulz-Zhecheva et al., 2019) to a self-report version for adults and termed it the *German Strengths and Weaknesses of ADHD and Normal-Behavior Scale Self-Report* (SWAN-DE-SB). Subsequently, we assessed this scale's psychometric properties in two partly overlapping samples: a general population sample including the percentage of individuals diagnosed with ADHD corresponding the prevalence of ADHD (i.e., approx. 2.5%; cf. Simon et al., 2009; Song et al., 2021) and a clinical sample of adults diagnosed with ADHD. Specifically, the SWAN-DE-SB's normality, internal consistency, factorial and convergent validity with established ADHD scales as well as its sensitivity and specificity in differentiating individuals with and without ADHD were assessed. The analyses presented here correspond to those of Schulz-Zhecheva and colleagues (2019). However, we performed principal axis factoring (PAF) instead of principal component analysis (PCA). PAF assumes measurement errors at the item level,

hence corresponding the assumptions of a Confirmatory Factor Analysis (CFA), while PCA does not. Also, we did not investigate the scale's convergent validity with respect to neuropsychological constructs.

Methods

Sample

Two partly overlapping samples, a *general population sample* comprising adults without ADHD and the number of participants with diagnosed ADHD corresponding the proportion of 2.5%, and thus the prevalence of ADHD expected for a general population sample (Simon et al., 2009; Song et al., 2021), and a *clinical sample* comprising adults with diagnosed ADHD, were established.

General Population Sample

Participants were recruited via e-mails sent to the university's staff and student mailing list, social media platforms, postings in university buildings, and through personal contacts, between April and May 2019. The sample thus recruited comprised 405 adults (110 male, 293 female, 2 diverse) with an average age of 28.57 years ($SD = 11.07$, min = 18, max = 71). Among them, 17 reported to have received an ADHD diagnosis earlier, and 14 indicated a current ADHD diagnosis. Ten of them reported ongoing pharmacological treatment for ADHD. All 17 participants indicating an earlier or current ADHD diagnosis were excluded from this group of participants. Subsequently, they were replaced by 11 randomly selected participants from the clinical sample (see below, i.e., 2.5%; Simon et al., 2009; Song et al., 2021). The random selection was stratified according to the distribution of the three presentations of ADHD, that is, the predominantly inattentive presentation (3 participants; 31%), the predominantly hyperactive-impulsive presentation (1 participant; 7%), and the combined presentation (7 participants; 62%; Wilens et al., 2009). The general population sample thus comprised 398 adults (109 male, 287 female, 2 diverse) at an average

age of 28.56 years ($SD = 11.09$, min = 18, max = 71). One of the participants underwent current pharmacological treatment for ADHD. In terms of educational attainment, 40.45% of the participants had a university degree (i.e., at least Bachelor's degree or diploma), 53.02% a high school diploma, 4.52% a secondary school leaving certificate, and 0.50% still attended secondary school (no information for 1.51% of participants) ¹.

Clinical Sample

Participants with a confirmed diagnosis of ADHD according to the DSM-5 (APA, 2013) were recruited through an ADHD outpatient clinic between March 2020 and April 2022. The sample comprised 49 adults (29 male, 19 female, 1 diverse) with an average age of 27.67 years ($SD = 6.38$, min = 19, max = 46). 25 of them were classified as predominantly inattentive, three as predominantly hyperactive-impulsive and 27 as combined presentations. Ten of them underwent current pharmacological treatment for ADHD. In terms of educational attainment, 14.29% of the participants had a university degree (i.e., at least Bachelor's degree or diploma), 46.94% a high school diploma, 34.69% a secondary school leaving certificate (no information for 4.08% of participants).

The study was approved by the local ethics committee. Participants were eligible for participation when at least 18 years old and after having provided informed consent for study participation. A very good knowledge of the German language was also required. Patients recruited through the ADHD outpatient clinic were reimbursed with 4.00 EUR. Participants recruited from the general population were reimbursed for their study participation by either a

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¹ Years spent in the German education system are: 9-10 years for a secondary school leaving certificate, 12-13 years for a high school diploma, and an additional 3-4 years for a Bachelor's degree and at least 5 years for a Master's degree or German diploma.

certificate for 0.5 test person hours (for university students in psychology programs) or by participation in a lottery of ten Amazon vouchers worth 5.00 EUR.

Procedure

Data from the population sample were obtained through an online survey tool (SoSci Survey; Leiner, 2021). Participants were first informed about the study and then asked to provide consent. Subsequently, they completed the ADHS-SB (Rösler, Retz-Junginger, et al., 2008), the CAARS-K-SB (Christiansen et al., 2014), and the SWAN-DE-SB. The questionnaires were presented in random order. Thereafter, participants were asked to report demographics such as age, gender, educational degree, a previous or current ADHD diagnosis, and whether they were currently medicated for ADHD. If they indicated current medical treatment, they were asked to inform about the name of the drug. Participants were required to indicate their e-mail address so that they could be contacted in case of a positive ADHD screening result based on the CAARS-K-SB (Christiansen et al., 2014). Additionally, they were required to provide answers to all items. Finally, they could indicate their e-mail address if they wished to participate in the lottery or their matriculation number and name if they wished to obtain credit points. E-mail addresses were stored separately from questionnaire data to ensure anonymity of the collected data.

Data from the clinical sample were obtained during visits at the ADHD outpatient clinic as part of a diagnostic assessment. First, participants were informed about the possibility to participate in this study and received written information. At their next appointment, their willingness to participate was ascertained and written consent for their study participation was taken. As part of the diagnostic process, participants completed the ADHS-SB (Rösler, Retz-Junginger, et al., 2008). Additionally, they completed the CAARS-K-SB (Christiansen et al., 2014), the SWAN-DE-SB, and a demographic questionnaire

asking about their age, gender, educational degree, and ADHD medication, as part of their study participation. All questionnaires were filled in on paper.

Measures

SWAN-DE-SB

The SWAN-DE-SB (see Supplement) was developed as an adaptation of the SWAN-DE (Schulz-Zhecheva et al., 2019). Activities commonly accomplished by children (e.g., playing, going to school) were replaced with activities associated with adult life (e.g., leisure time activities, going to work). Additionally, the item's wording was changed to first person singular. We first developed a pilot version comprising 23 items. In comparison with the SWAN-DE, it comprised five additional items as we aimed for a data-driven decision between two different wordings for two items (i.e., concerning the completion of work [Item 4]; concerning sitting still [Item 10]; see Supplement). We also included an item asking about inner restlessness, as it is assumed that hyperactivity undergoes a qualitative change in adults (APA, 2013). In addition to the 7-point rating scale ranging from -3 (*far below average*) to +3 (*far above average*), participants could also indicate if they did not understand the wording of an item. This pilot version was evaluated based on data provided by 33 adults (21 female, 12 male) aged between 18 and 80 years ($M = 37.2$ years, $SD = 16.9$). Distributions of the total scale and the subscales inattention and hyperactivity-impulsivity as well as a measure of internal consistency (Cronbach's α) were calculated. The results supported the normal distribution of the scales and adequate reliability. Additionally, answer tendencies were estimated for each item.

Based on this information, a version of the SWAN-DE-SB employed in the data collection in the community sample (no participants from the clinical sample included) was composed. It comprised 19 items, of which nine addressed inattention, nine hyperactivity-impulsivity, and one inner restlessness. Participants indicated their answers to the positively

worded items on a 7-point rating scale ranging from -3 (*far below average*) to +3 (*far above average*), while 0 indicated average. Lower scores thus reflected stronger ADHD symptoms. A CFA indicated the item on inner restlessness to load on neither of the two identified factors, wherefore it was excluded in the final version of the SWAN-DE-SB. The final version, comprising 18 items, was used for data collection in the clinical sample. All analyses presented below are therefore based on the information derived through 18 items, that is, the final version of the SWAN-DE-SB. The results presented are based on mean values of the two subscales inattention (SWAN-AD) and hyperactivity-impulsivity (SWAN-HI), both comprising nine items each, as well as a total scale (SWAN-TOT). Answers were transformed to range between 0 and 6.

ADHS-SB

The ADHD self-report scale (ADHS-SB; Rösler, Retz-Junginger, et al., 2008) is an established German self-report questionnaire assessing ADHD symptoms in adults using 18 items. Items are answered on a 4-point scale ranging from 0 (*does not apply*) to 3 (*severely pronounced*). In addition to a total score (ADHS-SB-TOT), the scale informed about inattention (ADHS-SB-AD), and overactivity-impulsivity (ADHS-SB-HI). Earlier studies found its retest reliability $r = .78 - .89$, internal consistency $\alpha = .72 - .90$, and convergent validity with the CAARS-K-SB ($r = .54 - .79$; Christiansen et al., 2014) to be adequate. Its sensitivity was found to be 65%, and its specificity 92% (Rösler, Retz-Junginger, et al., 2008).

CAARS-K-SB

The German short version of the Conners Adult ADHD Rating Scales (CAARS-K-SB; Christiansen et al., 2014) is a self-report questionnaire assessing ADHD symptoms in adults using 26 items. All items are answered on a 4-point rating scale ranging from 0 (*does not apply at all*) to 3 (*applies very strongly/frequently*), whereby higher values indicate

stronger ADHD symptoms. In addition to a total symptom score (CAARS-K-SB-TOT), the questionnaire provides values for inattention/memory problems (CAARS-K-SB-AD) and a composite scale representing hyperactivity-impulsivity calculated as the mean value of the scores on hyperactivity/motor restlessness and impulsivity/emotional lability (CAARS-K-SB-HI). The psychometric quality of the questionnaire was shown to be adequate, with Cronbach's $\alpha = .64 - .95$ and a convergent validity of $r = -.51 - .19$. No discrimination values were reported for the CAARS-K-SB, but for its corresponding long version. The long version's sensitivity was reported to range between 61 and 79% while its specificity was between 83 and 88%, depending on the subscale (Christiansen et al., 2014).

Data Analysis

All analyses were computed in the R software environment (R Core Team, 2022) and assumed an α -error probability of .05 (two-tailed). Besides basic R functions, psych (Revelle, 2022), paran (Dinno, 2018), lavaan (Rosseel, 2012), SBSDiff (Mann, 2018), and pROC packages (Robin et al., 2011) were used.

To determine the influence of gender, age, educational level, and interactions between them on SWAN-DE-SB scores, factorial Analyses of Variance (ANOVAs; Type II) were estimated. To evaluate normality of distribution, histograms and quantile-quantile plots (Q-Q plots) were inspected visually. Additionally, skew and kurtosis of the obtained scores were calculated. To assess the internal consistency of the SWAN-DE-SB, Cronbach's alphas were estimated for the total scale (SWAN-TOT) and both subscales (SWAN-AD, SWAN-HI). The scale's factorial structure was assessed using principal axis factoring (PAF) with promax rotation. Additionally, the fit of a non-hierarchical two-factor model and two bifactor models including a general ADHD factor (G-ADHD) and one factor for inattention (SP-AD) and hyperactivity-impulsivity (SP-HI) each, one with correlated measurement errors between items 5 and 7 as well as 2 and 6, and one without, was evaluated using CFA. Maximum

likelihood estimation with the robust standard errors (MLR) estimator was used. Missing values were handled using full information maximum likelihood (FIML). The scale's convergent validity was assessed based on Spearman's correlations between the SWAN-DE-SB, the CAARS-K-SB, and the ADHS-SB. To assess the clinical utility of the SWAN-DE-SB, differences in scores based on a diagnosis or no diagnosis of ADHD were estimated after controlling for age, gender, educational level, and their interactions using factorial Analyses of Covariance (ANCOVAs; Type II). Additionally, a receiver operating characteristics (ROC) curve analysis was computed and optimal cut-off values for specificity and sensitivity were identified. The scale's convergent validity was further assessed on the basis of Spearman's correlations between the SWAN-DE-SB, the CAARS-K-SB, and the ADHS-SB in the clinical sample.

Transparency and Openness

The authors of the present article took efforts to comply with the Transparency and Openness Promotion (TOP) Guidelines (Nosek et al., 2015). First, all program code and methods used for data analysis are quoted in the text and listed in the references section. Additionally, data and analysis codes are available in this work's OSF repository, https://osf.io/9zwsy/?view_only=70601fcbcf2042b1890d09db256b9ffc. Information on participants' gender is not contained in the data, however, to minimize the risk of identification due to the small number of participants with diverse gender. All data exclusions, manipulations, and study measures are reported. Furthermore, the SWAN-DE-SB questionnaire is presented in the Supplement. Finally, the present article complies with the APA Style Journal Article Reporting Standards (JARS-Quant). The present investigation's study design, hypotheses, and analyses have not been preregistered.

Results

SWAN-Scores, Age, and Gender

For the general population sample, mean SWAN-TOT score was $M = 3.77$ ($SD = 0.83$). Mean scores for the SWAN-AD were $M = 3.78$ ($SD = 0.92$) and $M = 3.76$ ($SD = 0.97$) for the SWAN-HI. Mean scores on the item level ranged between 2.64 and 4.37 ($SD = 1.25 - 1.54$). Mean scores of SWAN-AD, the SWAN-HI, and SWAN-TOT were highly correlated, $r_{\text{SWAN-AD-SWAN-HI}} = .56$, $r_{\text{SWAN-AD-SWAN-TOT}} = .88$, and $r_{\text{SWAN-HI-SWAN-TOT}} = .89$ (all $p < .001$). Univariate three-way ANOVAs indicated no significant effects of age on SWAN-TOT, SWAN-AD, and SWAN-HI (see Table 1). However, they revealed a significant effect of gender on the SWAN-TOT and SWAN-AD, but not SWAN-HI scores (Table 1, Figure 1). Males scored consistently lower than females, $M_{\text{SWAN-TOT (male)}} = 3.68$ ($SD = 0.95$), $M_{\text{SWAN-TOT (female)}} = 3.82$ ($SD = 0.77$), $M_{\text{SWAN-AD (male)}} = 3.60$ ($SD = 1.02$), $M_{\text{SWAN-AD (female)}} = 3.87$ ($SD = 0.85$), thus indicating stronger ADHD symptoms and inattention in males as compared to females. Additionally, educational level significantly affected SWAN-TOT, SWAN-AD, and SWAN-HI scores (Table 1, Figure 2), with higher educational level being related to lower ADHD symptoms. Also, the interaction of Gender x Educational Level significantly affected SWAN-HI scores. Post-hoc analyses revealed that educational level significantly predicted the SWAN-HI score for males, $b = 0.44$, $F(1,103) = 7.93$, $p < .01$, with higher educational level being associated with higher scores (i.e., better functionality), but not for females, $b = -0.01$, $F(1,279) = 0.69$, $p = 0.41$.

[insert Table 1 about here]

[insert Figure 1 about here]

[insert Figure 2 about here]

Distribution

SWAN-TOT, SWAN-AD, and SWAN-HI were approximately normally distributed as shown by visual inspection of histograms (Figure 3) and quantile-quantile plots (Q-Q plots; Figure 4). Skew and kurtosis were small, SWAN-TOT: skew = -0.12 ($z = -1.00$),

kurtosis = 0.51 ($z = 2.09$); SWAN-AD: skew = -0.48 ($z = -3.91$), kurtosis = 0.74 ($z = 3.05$); SWAN-HI: skew = 0.15 ($z = 1.26$), kurtosis = -0.34 ($z = -1.41$). All values were non-significant (z scores $< \pm 1.96$), except for the kurtosis of the SWAN-TOT and kurtosis and skew of the SWAN-AD.

[insert Figure 3 about here]

[insert Figure 4 about here]

Reliability

Cronbach's alphas were .90 for SWAN-TOT, .85 for the SWAN-AD, and .87 for the SWAN-HI, indicating excellent internal consistency for the total scale as well as both subscales. Additionally, every single item was significantly correlated with the total scale and both subscales, SWAN-TOT: $r = .48 - .73$, SWAN-AD: $r = .53 - .77$, SWAN-HI: $r = .62 - .77$, all $p < .05$.

Validity

The PAF revealed three factors with eigenvalues above 1. Yet, the parallel analysis scree plot (Figure 5) indicated that the third factor lied very close to the simulated data line. We therefore inspected both the three and the two rotated factor solutions. The three factor solution was not satisfying as item 10 and 11 did not load on any factor. The two factor solution yielded a satisfying result. Hence, compliant with earlier work (e.g., Christiansen et al., 2011; Conners et al., 1999; Schulz-Zhecheva et al., 2019), we assumed a two-factor structure of the data. After a promax rotation, the two components explained 43% of the variance. The nine items forming the SWAN-AD subscale and loading on component 1 explained 21% of the variance. The nine items forming the SWAN-HI subscale and loading on component 2 explained also 21% of the variance. Cross loadings were small ($< .30$).

The structure of the SWAN-DE-SB was further examined using CFA. The model fit of three models was evaluated according to criteria defined by Hu and Bentler (1999; Table

2). A non-hierarchical two-factor model (Model 1) showed an inferior fit in comparison with a bifactor model with a general factor (G-ADHD) and two specific factors of attention deficits (SP-AD) and hyperactivity-impulsivity (SP-HI). An inspection of the modification indices indicated that a model including correlated measurement errors between Items 5 (*“I organize tasks and activities”*) and 7 (*“I keep track of things necessary for activities”*) and between Items 2 (*“I sustain attention on tasks”*) and 6 (*“I engage in tasks that require sustained mental effort”*) should further increase the model fit (Model 3). Model 3 showed a significantly better fit than Model 2 as indicated by the Satorra-Bentler Chi-Square Difference Test, $\Delta\chi^2(2) = 20.96, p < .001$, and a tolerable model fit (see Table 2). The standardized factor loadings on the general factor (ADHD-G) and the two specific factors SP-AD and SP-HI as well as the R^2 values for the final model of the SWAN-DE-SB are presented in Table 3 (see also Figure 6). All items showed significant positive loadings on the ADHD-G and all items of the attention deficit subscale loaded significantly on the SP-AD. However, only five of the nine items of the hyperactivity-impulsivity subscale showed significant loadings on the SP-HI. The other five items showed strong loadings on the general factor.

[insert Table 2 about here]

[insert Table 3 about here]

[insert Figure 5 about here]

[insert Figure 6 about here]

Convergent validity was assessed by computing Pearson’s correlation coefficients between the SWAN-DE-SB and the ADHS-SB (sub)scales. Significant negative correlations were observed for all scales, SWAN-TOT ~ ADHS-SB-TOT: $r = -.59, p < .001$; SWAN-AD ~ ADHS-SB-AD: $r = -.63, p < .001$; SWAN-HI ~ ADHS-SB-HI: $r = -.54, p < .001$ (see Figure 7). The SWAN (sub)scales were also significantly negatively correlated with the

subscales of the CAARS-K-SB, SWAN-TOT ~ CAARS-K-SB-TOT: $r = -.42, p < .001$; SWAN-AD ~ CAARS-K-SB-AD: $r = -.54, p < .001$; SWAN-HI ~ CAARS-K-SB-HI: $r = -.38, p < .001$; see Figure 8). Additionally, SWAN scores were significantly negatively correlated with the ADHS-SB and CAARS-K-SB scores in the clinical sample, SWAN-TOT ~ ADHS-SB-TOT: $r = -.74, p < .001$; SWAN-AD ~ ADHS-SB-AD: $r = -.61, p < .001$; SWAN-HI ~ ADHS-SB-HI: $r = -.79, p < .001$; SWAN-TOT ~ CAARS-K-SB-TOT: $r = -.49, p < .001$; SWAN-AD ~ CAARS-K-SB-AD: $r = -.50, p < .001$; SWAN-HI ~ CAARS-K-SB-HI: $r = -.63, p < .001$.

[insert Figure 7 about here]

[insert Figure 8 about here]

As for the *clinical utility* of the SWAN-DE-SB, multifactorial, univariate ANCOVAs controlling for the influence of age, gender, educational level, and their interactions revealed significant differences between participants with and without a clinical diagnosis of ADHD. Participants with ADHD scored significantly lower on the SWAN-TOT, $M_{\text{ADHD}} = 1.88$ ($SD = 0.55$), $M_{\text{no ADHD}} = 3.82$ ($SD = 0.78$), $F(1,383) = 58.97, p < .001, \eta_p^2 = .15$, the SWAN-AD, $M_{\text{ADHD}} = 1.84$ ($SD = 0.81$), $M_{\text{no ADHD}} = 3.84$ ($SD = 0.86$), $F(1,383) = 49.12, p < .001, \eta_p^2 = .13$, and the SWAN-HI, $M_{\text{ADHD}} = 1.93$ ($SD = 0.57$), $M_{\text{no ADHD}} = 3.81$ ($SD = 0.93$), $F(1,383) = 39.55, p < .001, \eta_p^2 = .11$, indicating greater difficulties with inattention and hyperactivity-impulsivity. A ROC analysis revealed large area under the curve (AUC) values, SWAN-TOT: 98.53%, SWAN-AD: 94.93%, SWAN-HI: 96.08%, indicating an excellent differentiation ability of the SWAN-DE-SB between individuals with and without ADHD (cf. Swets, 1988). Optimal cut-off values for specificity and sensitivity were identified as follows: SWAN-TOT: 2.64 with a specificity of 100% and a sensitivity of 95.6%; SWAN-AD: 2.61 with a specificity of 90.91% and a sensitivity of 93.28%, SWAN-HI: 2.72 with a specificity of 90.91% and a sensitivity of 91.21%.

Discussion

The present investigation aimed to establish normality, internal consistency, and factorial and convergent validity of the SWAN-DE-SB, the self-report version of the German version Strengths and Weaknesses of ADHD-Symptoms and Normal-Behavior (SWAN) scale for adults. To this end, data from two partly overlapping samples, a general population sample of 398 adults (287 female, 109 male, 2 diverse), eleven of them with diagnosed ADHD (i.e., 2.5%; Song et al., 2021), and a clinical sample of 49 adults with diagnosed ADHD (19 female, 28 male, 1 diverse, no information for 1 participant) were analyzed. Information on the ethnicity of the participants was not obtained. Overall, the present investigation's findings supported the scale's excellent psychometric quality. The derived indicators were comparable with those of the original third-party report version of the SWAN scale (Swanson et al., 2012) and its translations (Table 4; Arnett et al., 2013; Chan et al., 2014; Lai et al., 2013; Lakatos et al., 2010; Lakes et al., 2012; Polderman et al., 2007; Robaey et al., 2007), in particular its German translation (Schulz-Zhecheva et al., 2019).
[insert Table 4 about here]

In accordance with previous evaluations of third-party report versions of the SWAN scale (see Table 4), the results of the present study supported the assumption of an approximately normal distribution on all its subscales. Additionally, findings indicated that the SWAN-DE-SB scale captures ADHD symptoms across the whole range of a continuously distributed trait. These findings suggest that the scale can therefore be used in studies examining general population samples. Additionally, the present findings support the assumption that ADHD symptoms are continuously distributed from very low to very pronounced in the general population (e.g., Coghill & Sonuga-Barke, 2012).

Additionally, the present findings indicated that male participants scored consistently lower than female ones on the total scale (SWAN-TOT) as well as the attention deficit

subscale (SWAN-AD) of the SWAN-DE-SB. The findings are thereby in line with results obtained in previous investigations (e.g., Gershon & Gershon, 2016). The findings furthermore indicated men to report higher scores with higher educational level. As higher scores reflect higher functionality, this finding is in line with previous research demonstrating that lower ADHD symptoms are associated with better academic functioning (e.g., Daley & Birchwood, 2010).

In line with findings considering the original version of the SWAN scale and translations (see Table 4), the SWAN-DE-SB showed excellent internal consistency as indicated by high Cronbach's alphas for the total scale and subscales and significant correlations of all individual items with the total scale and subscales. These findings furthermore emphasize the high psychometric quality of the SWAN-DE-SB.

Investigating the internal structure of the data, the results of the PAF and a CFA supported a two-factor structure of the SWAN-DE-SB. Model comparisons suggested a bifactor model with a general ADHD factor (G-ADHD) and one specific inattention (SWAN-AD) and hyperactivity-impulsivity factor (SWAN-HI) each to fit the data best. As such, the findings are in line with those of earlier research considering third-party report versions of the SWAN (e.g., Arnett et al., 2013; Normand et al., 2012; Schulz-Zhecheva et al., 2019; Swanson et al., 2012). The proportion of variance explained by the SWAN-DE-SB was lower compared to other studies using third-party report versions of the SWAN scale, and also lower than the values obtained for other commonly employed self-report questionnaires such as the CAARS-K-SB (60%; Christiansen et al., 2014) or the ADHS-SB (63%; Rösler, Retz, et al., 2008). The latter finding might thus indicate that further behavioral characteristics not reflected in the items of the present version of the SWAN-DE-SB might contribute to explaining variance in ADHD symptoms in the general adult population.

When comparing it to other commonly used ADHD scales, findings of the present investigation demonstrated the excellent convergent validity of the SWAN-DE-SB. Its total scale and the inattention and hyperactivity-impulsivity subscales were found to be significantly related to respective scales of the ADHS-SB (Rösler, Retz-Junginger, et al., 2008) and the CAARS-K-SB (Christiansen et al., 2014), two clinical scales commonly used in the diagnostic process of ADHD. The effect sizes obtained were in the same range as those of earlier studies (see Table 4). The SWAN-DE-SB may therefore be assumed to assess behaviors considered to reflect ADHD symptoms.

In terms of the clinical utility of the SWAN-DE-SB, the total and subscales were found to discriminate between individuals with and without ADHD diagnosis. Sensitivity and specificity were very high ($> 91\%$) throughout, and higher than most of those obtained in previous studies considering third-party report versions of the SWAN scale (see Table 4). The results were also comparable to values obtained for other established self-report measures, such as the ADHS-SB (Rösler, Retz, et al., 2008) and the CAARS-K-SB (Christiansen et al., 2014). The findings thereby underscore the clinical utility of the SWAN-DE-SB in the diagnostic process. In comparison to other questionnaires commonly used in clinical practice, the SWAN-DE-SB not only assesses weaknesses, but can be used to identify patients' strengths, which comprise an important starting point for psychotherapeutic treatment and the evaluation of treatment effects.

Limitations

Future studies aiming to replicate and extend the findings presented here may wish to consider the following limitations. First, while the present investigation demonstrated the convergent validity of the SWAN-DE-SB, other forms of validity, such as concurrent validity (cf. Schulz-Zhecheva et al., 2019), have not been assessed. Future studies may therefore

further examine the psychometric properties of the SWAN-DE-SB to further refine our view on the psychometric quality of this scale.

Additionally, the present study collected data from adults of all ages. Nevertheless, young adults made up the largest proportion of the sample. Additionally, no adolescents were included in the present study, although information on ADHD symptoms of adolescents is often collected through self-report in the diagnostic process and in research. Future studies may therefore examine the psychometric quality of the SWAN-DE-SB in adolescents and further specific age groups of adults.

Finally, the SWAN-DE-SB has been shown to discriminate individuals with and without ADHD. However, inattention and hyperactivity-impulsivity denote symptoms that are not only associated with an ADHD diagnosis but might also occur in the context of a range of mental disorders. Future studies may therefore wish to examine its potential to discriminate between individuals with ADHD and those with other mental disorders.

Constraints on Generality

In the present investigation, information on the participants' ethnicity was not obtained as this is not common practice in research conducted in Germany. It is therefore hardly possible to derive conclusions on the sample's diversity. However, due to our recruitment strategy in relation to the general population sample, which aimed to attract university staff and students in particular, we expect our sample to be comparatively white, educated, industrialized, rich, and democratic (i.e., WEIRD). Future studies may wish to replicate the current findings in a German representative population sample.

Conclusion

With the SWAN-DE-SB, the present study introduced the first self-report version of a dimensional scale assessing strengths and weaknesses of ADHD and normal behavior for adults. The present findings underscore its excellent psychometric quality. The scale may

therefore now be used to measure ADHD symptoms for research and clinical practice purposes.

Declaration of Conflicting Interests

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publications of this article.

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Table 1

Influence of age, gender, educational level and their interactions on SWAN-TOT, SWAN-AD, and SWAN-HI

	SWAN-DE-SB									
	SWAN-TOT				SWAN-AD			SWAN-HI		
	<i>df</i>	<i>F</i>	η_p^2	<i>p</i>	<i>F</i>	η_p^2	<i>p</i>	<i>F</i>	η_p^2	<i>p</i>
Gender	1	4.35	0.01	0.037*	11.83	0.03	<0.001*	0.11	<0.001	0.73
Age	1	0.89	<0.001	0.34	<0.001	<0.001	0.99	2.36	<0.001	0.11
Educational Level	1	10.80	0.03	0.001*	11.31	0.03	<0.001*	5.56	0.02	0.014*
Gender x Age	1	<0.001	<0.001	0.98	0.04	<0.001	0.82	0.03	<0.001	0.87
Gender x Educational Level	1	3.59	<0.001	0.059	0.80	<0.001	0.32	4.81	0.01	0.022*
Age x Educational Level	1	0.001	<0.001	0.97	0.02	<0.001	0.88	0.05	<0.001	0.82
Gender x Age x Educational Level	1	0.006	<0.001	0.92	0.04	<0.001	0.82	0.14	<0.001	0.70

Note. Gender: female = 1, male = 2. SWAN-TOT = SWAN total score, SWAN-AD = SWAN

attention deficit subscale, SWAN-HI = SWAN inattention/hyperactivity subscale.

Educational level: higher values indicate higher levels. Residual *df* for all models: 384; * *p* < .05.

Table 2*Model Fit Indices of the Confirmatory Factor Analysis of the SWAN-DE-SB*

	Model 1	Model 2	Model 3
Chi Square (<i>df</i>)	501.56 (134)	352.86 (117)	308.60 (115)
CFI	0.868	0.915	0.930
TLI	0.849	0.889	0.907
RMSEA	0.083	0.071	0.065
SRMR	0.061	0.042	0.040

Note. Model 1: Non-hierarchical model; Model 2: Bifactor model, no correlated measurement errors; Model 3: Bifactor model with correlated measurement errors allowed between items 5 and 7 and items 2 and 6.

df = degrees of freedom, CFI = Comparative Fit Index, TLI = Tucker-Lewis Index, RMSEA = Root Mean Square Error of Approximation, SRMR = Standardized Root Mean Squared Residual.

Table 3*PAF and CFA Results for the SWAN-DE-SB*

Item	PAF			CFA			R^2
	F1	F2	h^2	G-ADHD	SP-AD	SP-HI	
1. I pay close attention to details and avoid careless mistakes.	.49	.06	.28	.38 (.08)*	.38 (.09)*	-	.29
2. I maintain attention to tasks and activities.	.73	.01	.55	.53(.09)*	.50 (.11)*	-	.53
3. I listen when I am approached directly.	.45	.23	.38	.53 (.07)*	.32 (.10)*	-	.38
4. I finish work that I have started.	.80	-.11	.54	.50 (.09)*	.54 (.10)*	-	.54
5. I organize my tasks and activities.	.78	-.23	.44	.34 (.10)*	.54 (.11)*	-	.40
6. I volunteer for tasks that require sustained mental effort.	.52	.05	.30	.41 (.09)*	.35 (.10)*	-	.29
7. I keep track of the items required for my activities.	.81	-.13	.55	.46 (.08)*	.53 (.10)*	-	.49
8. I ignore external stimuli.	.39	.08	.20	.35 (.09)*	.28 (.09)*	-	.20
9. I keep everyday activities in mind.	.50	.15	.36	.50 (.09)*	.33 (.09)*	-	.36
10. I sit still.	.25	.47	.43	.69 (.08)*	-	.04 (.13)	.48
11. I remain seated when rules or social conventions require it.	.10	.63	.49	.72 (.08)*	-	.13 (.17)	.54
12. I regulate my motor activity.	.22	.59	.56	.81 (.06)*	-	.06 (.13)	.65
13. I maintain a noise level appropriate to the situation.	.06	.68	.51	.67 (.08)*	-	.29 (.14)*	.57
14. I come to rest and rest.	.20	.45	.35	.60 (.08)*	-	.09 (.13)	.37
15. I regulate my verbal activity and control excessive talking.	-.13	.64	.32	.38 (.11)*	-	.50 (.12)*	.39
16. I think about questions (before I burst out with an answer).	-.30	.87	.53	.44 (.14)*	-	.66 (.14)*	.63
17. I wait patiently until it is my turn.	.02	.60	.38	.52 (.07)*	-	.33 (.10)*	.38
18. I get into ongoing conversations without interrupting and disturbing them.	-.02	.70	.48	.57 (.09)*	-	.40 (.12)*	.41

Note. Table displays standardized loadings. PAF = principal axis factoring; CFA = confirmatory factor analysis; G-ADHD = general ADHD factor; SP-AD = specific attention deficit factor; SP-HI = specific hyperactivity/impulsivity factor. * $p < .05$

Table 4

Overview of Results of Validation Studies of the SWAN Scale (extended from Schulz-Zhecheva et al., 2019)

Study	Version	Distribution	Reliability		Validity			
			Cronbach's α	TRR	FV	CV	SP (%)	SE (%)
Swanson et al. (2012)	Original (T)	normal	–	–	2 factors; 87%	–	–	–
Polderman et al. (2007)	Original (P)	normal	–	–	–	-.38 – -.42 (CBCL-AP) -.57 – -.68 (DISC-4) -.79 – -.85 (Conner's Scale P) -.30 – -.32 (Conner's Scale T)	–	–
Robaey et al. (2007)	French (P)	normal	.88 – .91	–	–	.40 – .49 (CBCL-AP) .67 – .74 (SDQ-HI)	88	86
Lakatos, Birkas, Toth, & Gervai (2010)	Hungarian (P)	normal	.87 – .93	–	–	–	–	–
Lai et al. (2013)	Chinese (T & P)	normal	.90 – .95 (P), .97 – .98 (T)	.84 – .87 (P), .90 – .92 (T)	60% (P), 81% (T)	–	66-89	55-83
Lakes et al. (2012)	Spanish (Sp) & Original (Or; P)	normal	Sp: .91 – .95 Or: .92 – .95	Sp: .49 – .61 Or: .71 – .76	–	-.49 – -.54 (SDQ-HI)	–	–
Arnett et al. (2013)	Original (P)	normal	.88	.57 – .75	2 factors; 74%	.48 – .53 (DBRS)	98	58
Chan et al. (2014)	Chinese (T & P)	normal	–	–	–	.46 – .79 (DISC-4) -.43 – -.53 (CBCL-AP)	68–95	76–96
Schulz-Zhecheva et al. (2019)	German (P)	normal	.91 – .95	.77 – .81	2 factors; 65%	-.67 – -.68 (FBB-ADHS) -.54 – -.63 (ADHS-SB)	84	75-88
Present study	German (S)	normal	.85 – .90	–	2 factors; 43%	-.38 – -.54 (CAARS-K-SB)	91-100	91-95

Note. SWAN = Strengths and Weaknesses of ADHD-Symptoms and Normal-Behavior; TRR

= Test-Retest-Reliability; FV = factorial validity; CV = convergent validity; SP = specificity;

SE = sensitivity; P = parent report; T = teacher report; S = self-report; CBCL-AP = Child

Behavior Checklist, attention problems subscale; DISC-4 = Diagnostic Interview Schedule for Children Version 4; SDQ-HI = Strengths and Difficulties Questionnaire, hyperactivity-inattention subscale; DBRS = Disruptive Behavior Rating Scale; FBB-ADHS = Fremdbeurteilungsbogen ADHS.

Figure 1

Associations between the SWAN-DE-SB total score and subscale scores and age in male and female participants.

Note. SWAN-TOT = SWAN-DE-SB total score; SWAN-AD = SWAN-DE-SB attention deficit subscale; SWAN-HI = SWAN-DE-SB hyperactivity/impulsivity subscale.

Figure 2

Associations between the SWAN-DE-SB total score and subscale scores and age at different educational levels.

Note. SWAN-TOT = SWAN-DE-SB total score; SWAN-AD = SWAN-DE-SB attention deficit subscale; SWAN-HI = SWAN-DE-SB hyperactivity/impulsivity subscale.

Figure 3

Histograms Displaying the Distribution of Scores for the SWAN-DE-SB Total Score and Subscale Scores

Note. SWAN-TOT = SWAN-DE-SB total score; SWAN-AD = SWAN-DE-SB attention deficit subscale; SWAN-HI = SWAN-DE-SB hyperactivity/impulsivity subscale.

Figure 4

Quantile-Quantile Plots Displaying the Distribution of Scores for the SWAN-DE-SB Total Score and Subscale Scores against Theoretical Quantiles

Note. SWAN-TOT = SWAN-DE-SB total score; SWAN-AD = SWAN-DE-SB attention deficit subscale; SWAN-HI = SWAN-DE-SB hyperactivity/impulsivity subscale.

Figure 5

Scree-plot of the SWAN-DE-SB eigenvalues based on the actual and simulated data.

Figure 6*Structural model of the SWAN-DE-SB*

Figure 7*Relations between scales of SWAN-DE-SB and ADHS-SB*

Note. TOT scales = total scales of SWAN-DE-SB and CAARS-K-SB; AD scales = attention deficit scales of SWAN-DE-SB and CAARS-K-SB; HI scales = hyperactivity/impulsivity scales of SWAN-DE-SB and CAARS-K-SB.

Figure 8*Relations between scales of SWAN-DE-SB and CAARS-K-SB*

Note. TOT scales = total scales of SWAN-DE-SB and CAARS-K-SB; AD scales = attention deficit scales of SWAN-DE-SB and CAARS-K-SB; HI scales = hyperactivity/impulsivity scales of SWAN-DE-SB and CAARS-K-SB.