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Scale of Emotional Development – Short: reliability and validity in adults with intellectual disability

M. Flachsmeyer,[1] P. Sterkenburg,[2,3] B. Barrett,[4] S. Zaal,[5] J. Vonk,[6] F. Morisse,[7] F. Gaese,[8] M. Heinrich[9] & T. Sappok[10]

1 *Medical Faculty, Charité University, Berlin, Germany*
2 *Clinical Child and Family Studies, Vrije Universiteit Amsterdam, Amsterdam, The Netherlands*
3 *Department for Assessment and Treatment, Bartiméus, Doorn, The Netherlands*
4 *Department for Psychiatry and Psychotherapy, Stiftung Liebenau, Meckenbeuren, Germany*
5 *Cordaan, Amsterdam, The Netherlands*
6 *Lore behandel- en expertisecentrum, Het Warant, Helmond, The Netherlands*
7 *Outreach De Steiger, Psychiatric Centre Dr Guislain, Ghent, Belgium*
8 *Praxis for Psychiatry and Psychotherapy, Private Praxis, Munich, Germany*
9 *Division of Clinical-Psychological Intervention, Department of Education and Psychology, Freie Universität Berlin, Berlin, Germany*
10 *Bielefeld University, Medical School and University Medical Center OWL, Mara Hospital, University Clinic for People with Neurodevelopmental Disorders, Bielefeld, Germany*

Abstract

Background Intellectual disability (ID) is often associated with delays in emotional development (ED). The Scale of Emotional Development – Short (SED-S) was developed to assess the level of ED and to adapt treatment and care accordingly.
Methods In a sample of 724 adults from five study sites in three countries, a confirmatory factor analysis with a one-factor model was conducted on the entire dataset as well as in different subgroups. Furthermore, internal consistency was investigated using Cronbach's alpha.
Results The confirmatory factor analysis indicated that a single-factor model fits the SED-S data well. The subgroup analyses revealed good model fit, regardless of the severity of ID and irrespective of sex or the presence of autism spectrum disorder or psychiatric disorders. Internal consistency was excellent for the entire sample (Cronbach's alpha = 0.93) and various subgroups (0.869–0.938).
Conclusion The results of this study suggest that the SED-S is psychometrically sound and can be used to assess the level of ED in adults with ID.

Keywords assessment, emotional development, intellectual disability, mental disorders

Introduction

In addition to cognitive impairments, intellectual disabilities (IDs) are frequently associated with delayed emotional development (ED), which can lead to challenging behaviour or psychiatric disorders (Sappok *et al.* 2014; Hermann *et al.* 2022). The level of emotional functioning can provide insight into the inner experience, basic emotional needs and behaviour of people who may have difficulty

Correspondence: Prof Tanja Sappok, Bielefeld University, Medical School and University Medical Center OWL, Mara Hospital, University Clinic for People with Neurodevelopmental Disorders, Maraweg 17-21, 33617 Bielefeld, Germany (e-mail: tanja.sappok@t-online.de).

communicating these verbally (Dosen, 2005a, 2005b). Therefore, assessing the level of ED is a key element of the diagnostic process when working with individuals with an ID. Based on the developmental milestones in typically developing children, the Scale of Emotional Development – Short (SED-S) can be used to assess the level of ED (Sappok *et al.* 2016). The SED-S is a semi-structured interview that evaluates emotional reference ages from 0 to 12 years in eight different domains, resulting in an overall judgement of the level of ED (Sappok *et al.* 2020a). The trajectory of typical development in children provides a model that can be used to describe emotional needs and capacities in various psychosocial aspects; however, adults are not regarded as children and should not be assessed as such.

While, in the past, mental disorders were often not recognised in persons with ID, researchers now acknowledge that persons with ID can experience the full range of mental disorders (Matson & Peters 2020). Similar to the general population, they may develop mental health problems with prevalence rates ranging from 10% to 40% depending on the study population and diagnostic criteria used (Deb *et al.* 2001; Cooper *et al.* 2007; Mazza *et al.* 2020). In addition to mental disorders, the prevalence of challenging behaviours is increased in persons with ID, occurring in one out of four to five persons (Cooper *et al.* 2007; Bowring *et al.* 2017). Therefore, it is important to have a better understanding of the complex nature of ID in order to provide appropriate treatment and care in this highly vulnerable population.

Persons with ID may exhibit challenging behaviours for a variety of reasons, for example, low verbal ability, the co-occurrence of mental or neurodevelopmental disorders such as autism, psychotropic drugs and living situations (Bowring *et al.* 2017; O'Brien 2020). The level of ED may be one aspect of several associated with challenging behaviours, and lower levels of ED are associated with higher levels of challenging behaviours (Sappok *et al.* 2014). Interestingly, not only the severity but also the quality of problem behaviours changes according to the developmental level of a person as shown by Hermann *et al.* (2022). In the adaptation phase, stereotypy, self-aggression, hyperactivity, social withdrawal and isolation can be observed. The basic need in this phase is physical comfort. In the socialisation phase, high levels of externalising psychomotor activity and aggressiveness can be seen; the basic need is security. The individuation phase is characterised by impulsive, defiant and socially inappropriate behaviours and vocalisations. These behaviours are driven by the search for autonomy. The identification phase is characterised by inappropriate speech, verbal self-regulation and depressive-like symptoms such as mood swings, sadness and reduced motivation. The search for identity is key in this developmental period.

Moreover, certain mental disorders may affect emotional functioning. Autism spectrum disorders, for example, are associated with lower levels of ED (Sappok *et al.* 2019; Sappok *et al.* 2020b; Sterkenburg *et al.* 2021). A pilot study suggested that during acute depressive episodes, the level of emotional functioning decreases (Schmidt *et al.* 2021). In a pilot study, Lytochkin *et al.* (2021) showed that lower levels of ED were associated with schizophrenia, whereas anxiety disorder, dissociative disorder, personality disorders and substance abuse disorder predicted higher levels of ED. In this study, affective disorders were not associated with lower levels of ED.

Sterkenburg *et al.* (2022) examined the effects of physical and sensory impairments on emotional functioning. Interestingly, movement disorders were associated with more severe ID and lower levels of ED on the overall level and on certain domains (*others*, *body*, *material* and *communication*). Visual impairments only predicted lower levels of ED in the domains *material* and *body*, while hearing impairments were associated with neither ID nor ED. Epilepsy correlated only with the severity of ID but not with ED.

Therefore, a reliable and valid assessment of ED may be a useful addition to the evaluation and treatment of mental health concerns in persons with ID (Sappok *et al.* 2014, Dosen & De Groef 2015, O'Brien 2020). A valid and objective instrument is a prerequisite for a proper recognition of the emotional needs of the individual, which, in turn, may lead to a better quality of life and improved mental health (Schützwohl *et al.* 2018).

The current literature on the SED-S has already introduced the development of this instrument (Sappok *et al.* 2016). Furthermore, it has provided evidence of criterion validity at the item, domain and scale levels in typically developing children, with high

agreement between the domains of the SED-S and chronological age (Sappok *et al.* 2019). Index cases were developed to apply the SED-S in a standardised manner; they supported its use across different cultures (Sappok *et al.* 2020a). Moreover, the scale has been validated in a sample of children with ID and has demonstrated excellent internal consistency (Cronbach's alpha = 0.94). A principal component analysis indicated that a single component accounted for 72.4% of the explained variance in the eight domain scores of the SED-S (Sterkenburg *et al.* 2021). In 2016, a Belgian precursor version of the SED-S, the Scale for Emotional Development – Revised (Morisse & Došen 2017), was analysed for internal consistency and inter-rater reliability, with Cronbach's alpha of 0.95. The assessment of intraclass correlation coefficients showed moderate to substantial inter-rater reliability for 10 out of 13 domains (Vandevelde *et al.* 2016). In a sample of mentally healthy adults, a one-factor structure was confirmed, and internal consistency was high (Cronbach's alpha = 0.92) (Meinecke & Sappok 2021).

To date, the applicability in a sample of adults with ID and the psychometric properties of the SED-S have not yet been analysed (Gourley & Yates 2022). Rather, it has been mostly studied in children. Hence, this study adds to the validity of the scale in a sample of adults with ID, with further analyses regarding sex and certain comorbidities.

The aim of this study was to assess the factor structure and internal consistency in adults with ID, with and without mental disorders, across different levels of ID and sexes, and to determine its reliability and the construct validity in a multicentred design.

Methods

Setting and design

A sample of 724 adults with ID was recruited in Belgium, the Netherlands and Germany between May 2016 and November 2020. Inclusion criteria were age (>18) and having an ID; the exclusion criterion was a lack of consent. Consent for participation was given by the person or their legal guardians. Participants were recruited from hospitals and sheltered living institutions. In Belgium, the Tordale Care Institution in Torhout participated. In the Netherlands, four care organisations participated, namely, Cordaan in Amsterdam, ORO in Helmond, De Twentse Zorgcentra in Losser and Bartiméus in Doorn. In Germany, three hospitals for persons with ID and mental health problems participated, namely, Evangelisches Krankenhaus Königin Elisabeth Herzberge in Berlin, Kliniken des Bezirks Ostbayern – Klinikum München Oberbayern in Munich and St. Lukas-Klinik in Liebenau. Baseline variables, such as demographic information (e.g. age and sex) and information on additional disorders were systematically recorded upon assessment of the SED-S.

Assessments

The SED-S consists of 200 items assessing behaviours in eight domains and five stages, each with five items. The domains are (1) relating to his/her own body (short: body), (2) relating to significant others (others), (3) dealing with object permanence (object), (4) differentiating emotions (emotions), (5) relating to peers (peers), (6) engaging with the material world (material), (7) communicating with others (communication) and (8) regulating affect (affect). The stages are adaption (reference age: 0–6 months), socialisation (7–18 months), first individuation (19–36 months), identification (4–7 years) and reality awareness (8–12 years).

The items describe behaviours that are typical for children in the respective reference age, such as 'passively enjoys sensory stimulation' (adaption) or 'initiates social activities on his/her own' (reality awareness). A rating is given regarding whether the assessed behaviour is typical or not for the respective person based on caregiver and parent reports (binary yes–no response). The score for each domain is the stage with the highest number of 'yes' responses. The domain-specific results are ordered from low to high; the fourth lowest determines the overall level of emotional functioning. Higher scores in the SED-S indicate higher levels of ED.

The application and scoring are described in a detailed manual (Sappok *et al.* 2023). The interviews are conducted using a questionnaire on behaviour in different aspects of ED. The SED-S is applied by trained psychologists, psychiatrists, pedagogues or special education teachers. The interviews last from 30 to 60 min and are conducted with two to five informants, who are either family members or close

caregivers, that is, they know the respective person well, so they can determine their typical behaviours in various situations and aspects of daily life. Index cases for each level of ED standardise the scoring and allow the raters to compare their results with other administrators (Sappok *et al.* 2020a).

The severity of ID was diagnosed using the Disability Assessment Schedule (Holmes *et al.* 1982). The assessments of mental disorders were based on The International Statistical Classification of Diseases and Related Health Problems, 10th Revision (ICD-10) criteria. The respective physician provided this information.

Statistical analysis

The statistical analysis was conducted using RSTUDIO (version 1.3.1093) and SPSS (version 27).

Sample characteristics

Sample characteristics between the different study sites were compared using an analysis of variance with Tukey's honest significant difference as a *post hoc* test for continuous variables (i.e. age), Pearson's chi-squared test for nominal data (i.e. sex, mental disorder and autism spectrum disorder) and the Kruskal–Wallis test for ordinal data (i.e. level of ID).

The totals of several levels of ED and ID were calculated and tested for significant differences with the Kruskal–Wallis test. Furthermore, the Pearson rank correlation between ED and ID was determined.

Construct validity

Confirmatory factor analysis was conducted to evaluate the factorial validity of the eight domain scores of the SED-S. A one-factor model, in which the eight indicators (i.e. the domain scores of ED) load onto a single factor, was tested. The model's fit was then evaluated using the chi-squared test ($P > 0.05$ indicating good model fit). However, as minor misfits may cause a significant chi-squared value in large samples, we additionally considered the root mean square error of approximation (RMSEA), standardised root mean square residual (SRMR) and comparative fit index (CFI). A good model fit was determined using the following cut scores: RMSEA < 0.06, SRMR < 0.08 and CFI > 0.95 (Hu & Bentler 1999; Beauducel & Wittmann 2005; Schreiber *et al.* 2006). As the indicators were treated as ordered categorical variables, the diagonally weighted least squares (DWLS) estimation method, as implemented in the *lavaan* package, was used (Rosseel 2012; Kogar & Kogar 2016; Li 2016; Holgado-Tello *et al.* 2018; Rosseel 2020). For missing data, the *lavaan* package and the DWLS method employed pairwise deletion (proportion of missing values: 0–1.243%).

Invariance measurement

We further tested the fit of the one-factor model in multiple subgroups (i.e. female and male persons, persons with and without mental disorder or autism spectrum disorder, and the levels of ID). When all categories of all domains were present in all compared subgroups, measurement invariance was tested. It was assessed using the *semTools* package in R. An invariant measurement model indicates that the factor models describe the data similarly well in different subgroups and that the same construct is being measured. Invariance was tested at different stages (i.e. configural, metric and scalar). Invariance was considered to hold if the chi-squared test was non-significant, and the change in the CFI was <0.01 (Cheung & Rensvold 2002; Meade *et al.* 2008).

Internal consistency

Internal consistency as one estimate of reliability was assessed in terms of Cronbach's alpha on the domain level. Values >0.7 are satisfactory and >0.9 are excellent (Bland & Altman 1997; Streiner 2003).

Ethics

Ethical approval was obtained in each country separately. The Ghent University Ethics Commission for the Faculty of Psychology and Pedagogic Science granted permission to the care organisation in Belgium. In Germany, the Ethics Commission of the Charité University Hospital in Berlin (ethics vote: EA2/193/16) approved the study. Additionally, the Ethics Committee of the Königin Elisabeth Herzberge Hospital in Berlin approved the study's execution (22/11/16). The Ethics Committee of the Bayerische Landesärztekammer in Munich took the same stance (mb BO 17043). The Ethics Committee of Stiftung Liebenau approved the study in Liebenau. Each Dutch care organisation obtained ethical

approval from its own organisation's ethics commission (Bartiméus: 30/11/17; De Twentse Zorgcentra: 10/9/18; Cordaan: 28/8/17; and ORO: 24/5/17).

Results

Sample characteristics

The sample characteristics are displayed in Table 1. A total of 724 adults with ID participated. The ages ranged from 18 to 76 years, with an average age of 37.4 years. There were slightly more male participants (56.4%) than females. The severity of ID ranged from mild (28.2%) to profound (7.6%), with the most frequent being moderate ID (37.4%). Most participants had a mental disorder (83.8% in total; dementia 2.6%, addiction disorder 1.4%, schizophrenia 11.3%, mood disorders 13.4%, anxiety/obsessive–compulsive disorder 10.8%, personality disorders 3.3%, autism spectrum disorders 30% and challenging behaviour 47.5%).

Differences between the study sites

Participants from Belgium were older than those from Berlin and Munich ($P = 0.002$). In Belgium, the proportion of males was larger in comparison with the other study sites ($P < 0.001$). The severity of ID differed significantly between Munich and Berlin, with more severe impairments in Berlin. In Munich, all participants had a mental disorder. In the Belgian sample, additional mental disorders were reported less often compared with the other samples. There were no significant differences ($P < 0.081$) in the

Table 1 Sample characteristics

	Total (*N* = 724)	**Belgium (*n* = 50)**	**Berlin (*n* = 485)**	**Liebenau (*n* = 52)**	**Munich (*n* = 84)**	**The Netherlands (*n* = 53)**	**Test statistic and *P***	***Post hoc***
Age range in years (*M*)	18–76 (37.4)	22–68 (43.8)	18–76 (36.8)	20–67 (37)	18–64 (35.4)	18–67 (40.4)	$F_{4, 719} = 4.334$, $P = 0.002$	BL > B, BL > M[†]
Sex (male/female)	408/316	41/9	291/194	26/26	27/57	23/30	$\chi^2(4) = 40.482$, $P < 0.001$	BL > B, BL > L, BL > M, BL > N, B > M[‡]
Severity of ID, *n* (%)							$\chi^2(4) = 32.468$, $P < 0.001$	B ≠ M[‡]
Mild	204 (28.2)	17 (34)	117 (24.1)	17 (32.7)	30 (35.7)	20 (37.7)		
Moderate	271 (37.4)	22 (44)	164 (33.8)	24 (46.2)	45 (53.6)	18 (34)		
Severe	194 (26.8)	11 (22)	159 (32.8)	8 (15.4)	9 (10.7)	8 (15.1)		
Profound	55 (7.6)	0	45 (9.3)	3 (5.8)	0	7 (13.2)		
Mental disorder, *n* (%)							$\chi^2(4) = 53.393$, $P < 0.001$	BL > B, BL > L, BL > M, BL > N, N > L, N > M, B > M[‡]
Yes	607 (83.8)	28 (56)	405 (83.5)	50 (96.2)	84 (100)	40 (75.5)		
No	117 (16.2)	22 (44)	80 (16.5)	2 (3.8)	0	13 (24.5)		
ASD, *n* (%)							$\chi^2(4) = 8.294$, $P < 0.081$	
Yes	217 (30)	12 (24)	145 (29.9)	12 (25)	35 (41.7)	12 (22.6)		
No	507 (70)	38 (76)	340 (70.1)	39 (75)	49 (58.3)	41 (77.4)		

In the comparison of sex, '>' means more males than females; in the comparison of mental disorder, '>' means more persons with mental disorder than without.

[†]Tukey's HSD as *post hoc* test.

[‡]Pairwise comparisons as *post hoc* test.

ASD, autism spectrum disorder; B, Berlin; BL, Belgium; HSD, honestly significant difference; ID, intellectual disability; L, Liebenau; M, Munich; N, The Netherlands.

prevalence of autism spectrum disorder. All the differences can be seen in Table 1.

Emotional development in adults with intellectual disability

The different distributions of the SED-S stages are presented in Fig. 1. The distribution of the different stages of ED in the entire sample showed that stage 3 'first individuation' was the most prevalent (36%), while stage 1 'adaption' and stage 5 'reality awareness' were significantly less prevalent, with 15% and 3%, respectively. The distribution of the five developmental stages was similar at all study sites, with no significant differences found, $\chi^2(4) = 7.364$, $P = 0.118$.

The level of ED correlated with the severity of ID. More severe forms of ID showed lower levels of ED. There were significant differences in the distribution of ED among the levels of ID, $\chi^2(3) = 272.97$, $P < 0.001$. Persons with mild ID showed higher levels of ED and vice versa. A correlation matrix of this analysis is shown in Table 2. A strong negative association was found between ED and ID, Pearson's rank correlation coefficient $r = -0.606$, $P < 0.001$.

Figure 2 shows the different distributions of ED in the subgroups. The distribution between females and males showed no significant difference, $\chi^2(1) = 0.99$, $P = 0.32$. The distribution for the comparison of persons with and without mental disorder(s), $\chi^2(1) = 4.496$, $P = 0.034$, and persons with and without autism spectrum disorder, $\chi^2(1) = 91.699$, $P < 0.001$, was significantly different. Most persons with autism spectrum disorder (92.6%) were assigned to SED-S levels 1 to 3.

Construct validity

A one-factor model with eight variables, the domain scores, that hypothetically load onto one factor (ED) was tested in the confirmatory factor analysis. Figure 3 illustrates this one-factor model with the standardised factor loadings.

The one-factor model fitted the data well, $\chi^2 = 32.123$, d.f. = 20, $P = 0.019$, RMSEA (90%

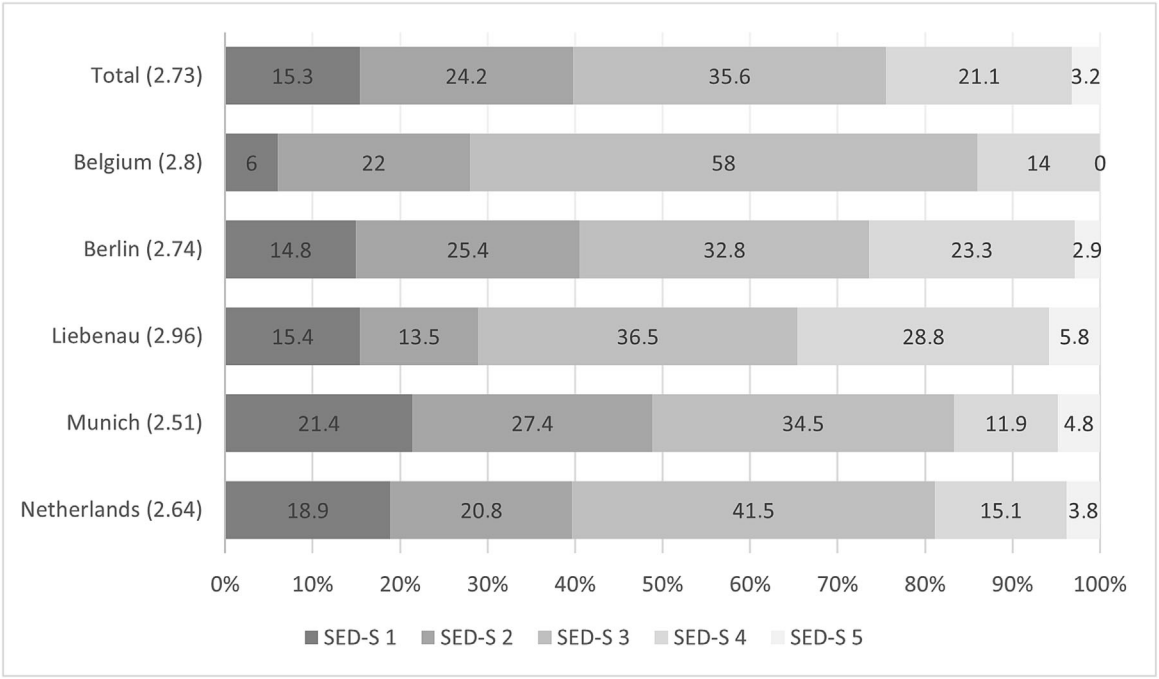

Figure 1. Distribution of the different levels of emotional development (ED) at all the study sites with the mean value of ED in brackets after each study site and the proportions shown in the graph. SED-S *x*, stage of the Scale of Emotional Development – Short.

Table 2 Cross table of the different levels of ED and levels of severity of ID (%)

	SED-S 1	SED-S 2	SED-S 3	SED-S 4	SED-S 5	Total
Mild ID	4 (2)	15 (7.5)	78 (38.8)	85 (42.3)	18 (9)	200 (27.6)
Moderate ID	12 (4.4)	62 (22.7)	135 (49.5)	57 (20.9)	4 (1.5)	270 (37.3)
Severe ID	67 (34.4)	76 (39)	40 (20.5)	11 (5.6)	1 (0.5)	195 (26.9)
Profound ID	28 (50.9)	22 (40)	5 (9.1)	0	0	55 (7.6)
Total	111 (15.3)	175 (24.2)	258 (35.6)	153 (21.1)	23 (3.2)	720 (99.4)

The shaded areas represent the corresponding reference ages of the severity of ID and the level of ED.
ED, emotional development; ID, intellectual disability; SED-S, Scale of Emotional Development – Short.

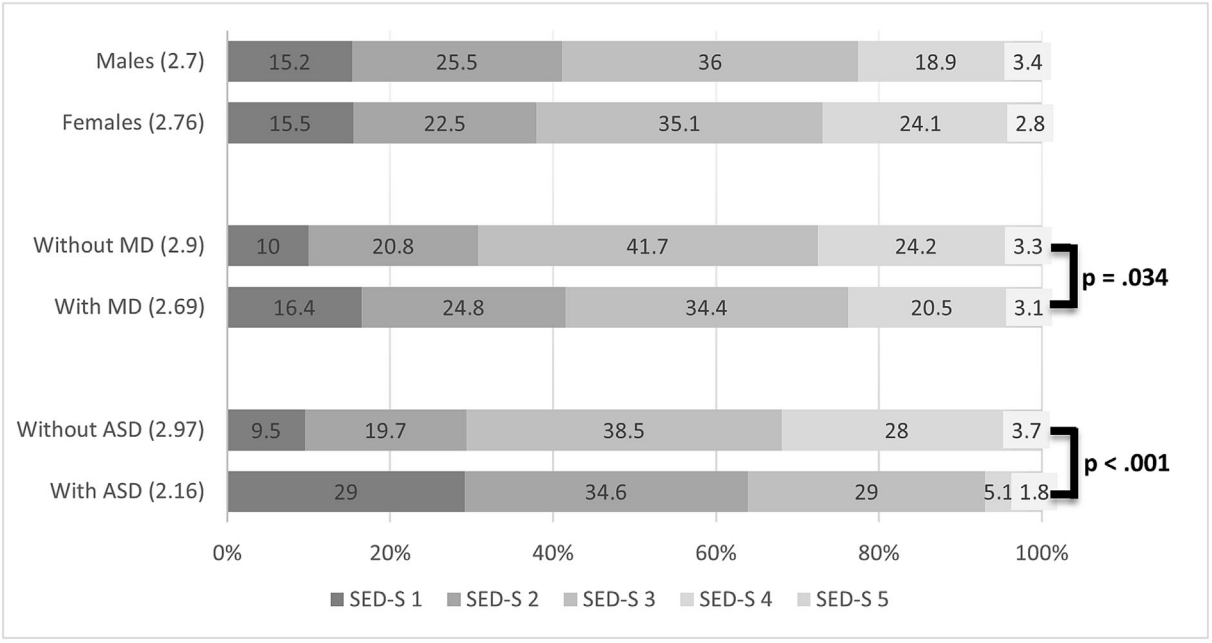

Figure 2. Distribution of the different stages of emotional development (ED) in females and males, persons with and without mental disorder (MD) and persons with and without autism spectrum disorder (ASD) with the mean value of ED in brackets after each study site, the proportions shown in the graph, and the significant *P*-values added for persons with and without MD and persons with and without ASD. SED-S *x*, stage of the Scale of Emotional Development – Short.

confidence interval) = 0.032 (0.013–0.050), CFI = 0.999 and SRMR = 0.022.

Table 3 shows the parameter estimates of the confirmatory factor analysis, including standardised and unstandardised estimates, standard error, *z*-value, *P*-value and residual variances. The factor loadings ranged from 0.869 for the domain 'communication' to 0.777 for the domain 'object'.

Invariance measurement

Mental disorder versus non-mental disorder

Measurement invariance of the single-factor models was tested for persons with (n = 607) and without mental disorder (n = 117). The models showed good fit in both groups and for different stages of measurement invariance (cf. Table 4). Table 5 shows the factor loadings.

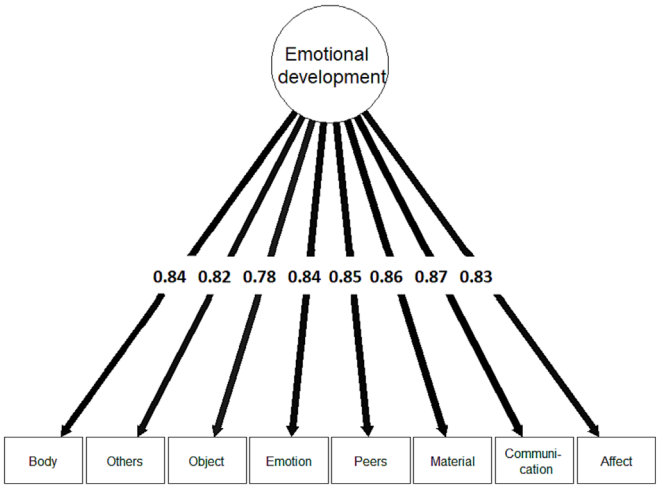

Figure 3. Tree diagram representing the one-factor model of emotional development with standardised factor loadings for each domain in the whole dataset.

Table 3 Parameter estimates of the confirmatory factor analysis

Emotional development	Standardised estimate	Unstandardised estimate	SE	z-value	*P*-value	Residual variances
Body	0.840	1			<0.001	0.294
Others	0.816	0.972	0.018	55.284	<0.001	0.334
Object	0.777	0.925	0.018	50.630	<0.001	0.396
Emotion	0.839	0.999	0.017	57.216	<0.001	0.297
Peers	0.847	1.009	0.018	57.040	<0.001	0.282
Material	0.864	1.028	0.018	56.969	<0.001	0.254
Communication	0.869	1.035	0.018	58.892	<0.001	0.244
Affect	0.833	0.992	0.017	57.788	<0.001	0.306

SE, standard error.

Table 4 Fit parameters and measurement invariance of the confirmatory factor analysis of persons with and without mental disorder

	χ^2	d.f.	$P(\chi^2)$	$\Delta\chi^2$	CFI	ΔCFI	RMSEA	90% CI of RMSEA	SRMR
With MD	32.249	20	0.041		1.000		0.032	0.007–0.051	0.022
Without MD	14.547	20	0.802		1.000		<0.001	0.000–0.052	0.042
Configural invariance	46.796	40	0.214		1.000		0.022	0.000–0.044	0.025
Metric invariance	58.283	47	0.119	11.488	1.000	<0.001	0.026		
Scalar invariance	90.528	70	0.095	32.244	0.999	<0.001	0.029		

CFI, comparative fit index; CI, confidence interval; MD, mental disorder; RMSEA, root mean square error of approximation; SRMR, standardised root mean square residual.

Sex

Measurement invariance of the one-factor models was tested for males (n = 408) and females (n = 316). Good fit was shown in both groups and for different stages of measurement invariance (Table 6). The factor loadings are shown in Table 5.

Table 5 Standardised factor loadings of the entire sample and subgroup analyses

	Entire sample	With MD	Without MD	Females	Males	With ASD	Without ASD	Mild ID	Moderate ID	Severe ID	Profound ID
Body	0.840	0.844	0.851	0.855	0.828	0.842	0.816	0.636	0.725	0.826	0.843
Others	0.816	0.829	0.725	0.832	0.805	0.811	0.795	0.750	0.682	0.840	0.778
Object	**0.777**	**0.786**	**0.718**	**0.789**	**0.770**	**0.776**	**0.755**	**0.616**	**0.670**	0.772	0.829
Emotion	0.839	0.845	0.781	0.827	*0.851*	0.803	0.820	0.761	*0.830*	0.744	**0.675**
Peers	0.847	0.858	0.780	0.859	0.840	0.855	0.807	0.770	0.774	0.834	0.738
Material	0.864	0.869	0.845	0.888	0.846	*0.875*	0.833	0.632	0.739	*0.872*	*0.912*
Communication	*0.869*	*0.874*	*0.869*	*0.889*	0.850	0.835	*0.858*	0.806	0.782	**0.742**	0.735
Affect	0.833	0.839	0.793	0.847	0.825	0.824	0.799	*0.833*	0.688	0.764	0.789

Lowest factor loadings are in bold; highest factor loadings are in italics.
ASD, autism spectrum disorder; ID, intellectual disability; MD, mental disorder.

Table 6 Fit parameters and measurement invariance of the confirmatory factor analysis of females and males

	χ^2	d.f.	$P(\chi^2)$	$\Delta\chi^2$	CFI	ΔCFI	RMSEA	90% CI of RMSEA	SRMR
Females	16.859	20	0.662		1.000		<0.001	0.000–0.040	0.021
Males	28.403	20	0.100		0.999		0.032	0.000–0.057	0.027
Configural invariance	45.263	20	0.262		1.000		0.019	0.000–0.042	0.025
Metric invariance	52.038	47	0.454	6.776	1.000	<0.001	0.017		
Scalar invariance	63.258	70	0.981	11.22	1.000	<0.001	0.000		

CFI, comparative fit index; CI, confidence interval; RMSEA, root mean square error of approximation; SRMR, standardised root mean square residual.

Autism spectrum disorder versus non-autism spectrum disorder

The latent construct fitted well for the comparison of the groups of persons with (n = 217) and without autism spectrum disorder (n = 507). The fit parameters are given in Table 7. Measurement invariance across both groups showed that invariance was present for all parameters except the scalar invariance. However, because the ΔCFI was <0.01, measurement invariance was still present across all invariance models (cf. Table 7). Factor loadings are shown in Table 5.

Different levels of intellectual disability

Fit parameters for the group analyses of all levels of ID [mild (n = 201), moderate (n = 273), severe (n = 195) and profound (n = 55)] are shown in Table 8. The fit parameters indicated good model fit for all subgroups, with the exception of those persons with profound ID, whose SRMR was not within the thresholds. This may be due to the groups' small sample size. The factor loadings are shown in Table 5. A formal test of measurement invariance was not possible because not all developmental levels were present in each group. Only separated group analyses were possible.

Internal consistency

To assess the reliability and internal consistency of the SED-S, Cronbach's alpha was calculated on the domain level. For the entire dataset, internal consistency of the questionnaire was excellent, with α = 0.932.

In addition, the internal consistency of the SED-S was tested in different subgroups; the results are shown in Table 9. They showed satisfactory internal consistency for all subgroups, with Cronbach's alpha above 0.869 (Bland & Altman 1997; Streiner 2003).

Table 7 Fit parameters and measurement invariance of the confirmatory factor analysis of persons with and without autism spectrum disorder

	χ^2	d.f.	$P(\chi^2)$	$\Delta\chi^2$	CFI	ΔCFI	RMSEA	90% CI of RMSEA	SRMR
With ASD	21.612	20	0.362		1.000		0.019	0.000–0.063	0.034
Without ASD	21.791	20	0.352		1.000		0.013	0.000–0.041	0.023
Configural invariance	43.404	20	0.328		1.000		0.015	0.000–0.040	0.026
Metric invariance	50.208	47	0.450	6.80	1.000	<0.001	0.014		
Scalar invariance	87.884	70	0.028	37.68	0.999	0.001	0.027		

ASD, autism spectrum disorder; CFI, comparative fit index; CI, confidence interval; RMSEA, root mean square error of approximation; SRMR, standardised root mean square residual.

Table 8 Fit parameters of the confirmatory factor analysis of several levels of intellectual disability

	χ^2	d.f.	$P(\chi^2)$	CFI	RMSEA	90% CI of RMSEA	SRMR
Mild ID	8.013	20	0.992	1.000	<0.001	0.000–0.000	0.029
Moderate ID	29.507	20	0.078	0.998	0.042	0.000–0.072	0.042
Severe ID	14.768	20	0.790	1.000	<0.001	0.000–0.042	0.035
Profound ID	20.194	20	0.446	1.000	0.013	0.000–0.118	0.086

CFI, comparative fit index; CI, confidence interval; ID, intellectual disability; RMSEA, root mean square error of approximation; SRMR, standardised root mean square residual.

Table 9 Cronbach's alpha of the subgroup analyses

Subgroup		Cronbach's alpha
Sex	Females	0.938
	Males	0.926
Mental disorder	With MD	0.935
	Without MD	0.908
ASD	With ASD	0.917
	Without ASD	0.922
Level of ID	Mild ID	0.876
	Moderate ID	0.878
	Severe ID	0.901
	Profound ID	0.869

ASD, autism spectrum disorder; ID, intellectual disability; MD, mental disorder.

Discussion

This study aimed to evaluate the construct validity and reliability of the SED-S in adults with ID. The study found that individuals with more severe forms of ID and those with additional mental disorders and autism spectrum disorder had lower levels of ED. The level of ED did not differ between men and women. The data supported the one-factor model of the SED-S, which was tested using confirmatory factor analysis and was found to be valid independent from sex, mental disorder, autism spectrum disorder and the severity of ID. Cronbach's alpha indicated an excellent internal consistency of the SED-S for the entire sample and different subgroups. These results support the unidimensionality and internal consistency of the SED-S in adults with ID. For persons with an additional mental disorder, the SED-S assesses ED regardless of the presence of the mental disorder. Understanding the current level of ED may prevent the occurrence of mental disorders by recognising the specific needs and providing better support in difficult situations.

The severity of ID was inversely correlated with the level of ED; more severe forms of ID were associated with lower levels of ED and vice versa. This strong negative correlation was consistent with the findings

of previous research using the SED-S (Sappok *et al.* 2020a; Meinecke & Sappok 2021; Sterkenburg *et al.* 2021; Hermann *et al.* 2022). In persons with severe to profound ID, stages 1 to 3 were most frequently found. In persons with mild and moderate ID, a wider range of ED levels was observed, indicating greater independence from cognitive and emotional functioning in this population. Furthermore, there may be a ceiling effect, meaning it is more difficult to have a more severe ID and a high stage of ED than the other way around.

The distribution of the levels of ED was similar at all study sites, underlining the applicability of the SED-S in different countries and languages. The analysis showed no significant differences in the distribution of ED between females and males; it is equally applicable to both sexes.

Moreover, persons with mental disorder had slightly lower levels of ED compared with those without mental disorder. This was likewise observed in a systematic comparison of persons with and without autism spectrum disorder (Sappok *et al.* 2016; Sappok & Zepperitz 2019) and in a pilot study of persons with mood disorders (Schmidt *et al.* 2021). It appears that the level of emotional functioning decreases in persons experiencing an acute episode with mental health problems. Therefore, the level of ED should be assessed twice, once during the mental disorder and again after recovery.

Further, persons with autism spectrum disorder showed lower levels of ED than those without. This may be due to an overlap of the model of ED and certain diagnostic criteria for autism spectrum disorder, such as social, sensorimotor and communicative aspects (Dziobek *et al.* 2008; Kasari *et al.* 2012; Sappok *et al.* 2013). Another explanation may be difficulties with emotion recognition and regulation in persons with autism spectrum disorder as a result of possible delays in the development of emotional functioning brain circuits (Sappok *et al.* 2020b). Sappok *et al.* (2020b) have already reported lower developmental levels in persons with autism spectrum disorder compared with those without.

Research on the influence of the ED level on further mental disorders showed an association of schizophrenia with lower levels of ED and an association of anxiety disorders, dissociative disorder, personality disorder and substance abuse disorder with higher levels of ED (Lytochkin *et al.* 2021). Affective disorders could be seen across several levels of ED (Lytochkin *et al.* 2021). Furthermore, no association of the level of ED and epilepsy could be seen in two different samples (Pena-Salazar *et al.* 2021; Sterkenburg *et al.* 2022).

In further studies, the construct validity may be examined in a larger sample of persons with IDs and certain mental disorders.

A confirmatory factor analysis with a single factor fits the data well (Hu & Bentler 1999; Beauducel & Wittmann 2005; Schreiber *et al.* 2006). The high factor loadings indicated a correlation between the eight domains, which measure the same construct (ED). There may be overlap in the content of items from different domains, which could contribute to the high factor loading, for example, Body1_1 ('emotional states are largely determined by basic physical sensations and needs') and Material1_1 ('is mainly preoccupied with his/her own body'). The overlap of items from different domains should be further examined.

All indicators share a large proportion of reliable variance with the common factor. The residual variance (i.e. the variance not accounted for by the common factor) is similar for all indicators. This suggests that all indicators are reliable indicators of the ED factor.

The indicators 'communication' and 'material' share the largest amount of reliable variance with the common factor. One reason for the high factor loadings in the domain 'material' may be that playing in and exploring the material world can help the people process experiences and emotionally difficult situations, which plays a major role in ED.

Furthermore, the domain 'communication' may play a significant role because verbal and nonverbal communication is part of every aspect of life. This may overlap with the other seven domains, leading to a high correlation between ED and 'communication'.

The domain 'object' appeared to be the least affected. This may be due to the more cognitive aspects measured in the domain 'object' (object permanence). Furthermore, it may be difficult to assess object permanence in a stagewise manner, as it may be either present or absent. We therefore suggest carefully re-examining the items in this domain with regard to phrasing.

Overall, the differences between the factor loadings were small; all loadings were homogenous. The

indicators seem to be similarly appropriate for the one factor.

The construct validity of the SED-S was previously analysed in samples of children with ID (Sterkenburg *et al.* 2021) and mentally healthy adults with ID (Meinecke & Sappok 2021). Both studies found that all eight domains strongly loaded onto a single factor. In both studies, the domain 'object' had the lowest factor loading.

The subgroup analyses of sex, mental disorders and autism spectrum disorder confirmed the one factor across different subgroups. The same pattern of factor loadings emerged, with the domains 'communication' and 'material' having the highest factor loadings and the domain 'object' having the lowest factor loadings. However, all factor loadings were very similar to each other and strong.

The confirmatory factor analysis across the different levels of ID indicated a good fit for a one-factor model for all ID levels. In persons with mild ID, the domains 'affect' and 'communication' had the strongest loading on the ED factor, while in persons with moderate ID, the domain 'emotion' had the highest factor loading. In both mild and moderate IDs, the domain 'object' had the lowest loading on the ED factor.

Persons with less severe ID (mild and moderate) are able to better distinguish between various emotions and their causes; they can logically understand and evaluate the consequences of their actions. This may explain the high loadings of 'affect', 'communication' and 'emotion'. In contrast, persons with severe ID had the highest factor loadings in the domains regarding the material world ('material'), the body ('body') and close caregivers ('others'). Furthermore, those with profound ID had the highest factor loadings in the domains of the material world ('material'), the body ('body') and the domain 'object'. These high factor loadings for people with severe and profound ID may be due to the focus on the self and objects, as well as their close connection to direct caregivers in the lower developmental stages. The group of persons with profound ID was the only one with high factor loadings in the domain 'object'. This may be because profound deficits in cognitive development can limit an individual's ED, and dealing with objects does not require cognitive demands.

The internal consistency of the SED-S was high for the entire sample and the subgroups. These results suggest that the SED-S is a reliable measure for assessing the level of ED. Previous studies by Vandevelde *et al.* (2016) ($\alpha = 0.95$), Sterkenburg *et al.* (2021) ($\alpha = 0.94$) and Meinecke & Sappok (2021) ($\alpha = 0.92$) provided additional evidence for the reliability of the SED-S score.

Confirmatory factor analysis was used in this study rather than exploratory factor analysis because the aim was to examine the theoretical construct of the SED-S. The variables were ordinal and not normally distributed, but the DWLS estimation method was used to compensate for this potential limitation. However, cultural and language invariance and invariance concerning the recruitment and living situation were not investigated but were implicitly assumed. Only group differences were analysed and not the invariance itself.

Additionally, some subgroups were small in size. The distribution of persons in different levels of ED was uneven, with only a few scores in SED-S 5. This unbalanced distribution should be considered in future studies. Similarly, the group of persons with profound ID was quite small. As the participants were recruited from hospitals and sheltered living institutions, the sample is representing a selected group of persons with additional mental health problems and/or severe problem behaviours. Thus, an analysis of the structural model of the scale in a more capable person without additional mental health issues should be applied in a further study to confirm the validity of the scale in this subgroup of persons with ID as well. Moreover, the inter-rater reliability and the test–retest reliability need to be examined in further studies as the current study assessed the reliability only in terms of internal consistency.

Given the lack of literature on the scale's validity, especially in adults with ID, in future studies, research should examine inter-rater and retest reliability. Future research should focus on the SED-S 6 (Sappok *et al.* 2023), and on adding another additional developmental stage (SED-S 7) and on somatic disorders, using a large sample and similar validation models to those in this study. However, the study's large sample size and the multicentred design with five study sites in three different countries are a major strength.

Valid assessment of the level of emotional functioning can help professionals working with people with ID better understand their emotional needs and certain behaviours. The results can be used to guide recommendations for providing the best possible support tailored to their specific needs. The developmental approach can provide professionals and caregivers with a reference framework to facilitate diagnostic evaluation and enable them to better attune settings and interactions to the specific needs of the individual.

In conclusion, the SED-S demonstrated high internal consistency and factorial validity in adults with ID. The SED-S is applicable across several levels of ID, as well as in both sexes, persons with and without any mental disorder and persons with and without autism spectrum disorder. These findings suggest that the SED-S is psychometrically sound and can be used to assess the level of ED in adults with ID, thus potentially improving medical care for this highly vulnerable population.

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Conflict of interest

Tanja Sappok and Brian Barrett received royalties from Hogrefe and Kohlhammer for the publication of the SED-S and other book projects. This paper is part of the doctoral dissertation of Miriam Flachsmeyer.

Ethical approval statement

Ethical approval was obtained in each country separately. The Ghent University Ethics Commission for the Faculty of Psychology and Pedagogic Science granted permission to the care organisation in Belgium. In Germany, the Ethics Commission of the Charité University Hospital in Berlin (ethics vote: EA2/193/16) approved the study. Additionally, the Ethics Committee of the Königin Elisabeth Herzberge Hospital in Berlin approved the study's execution (22/11/16). The Ethics Committee of the Bayerische Landesärztekammer in Munich took the same stance (mb BO 17043). The Ethics Committee of Stiftung Liebenau approved the study in Liebenau. Each Dutch care organisation obtained ethical approval from its own organisation's ethics commission (Bartiméus: 30/11/17; De Twentse Zorgcentra: 10/9/18; Cordaan: 28/8/17; and ORO: 24/5/17).

Data availability statement

Data are available upon request.

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