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CONTENTS

⬢ Research

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Cognitive, language and motor development in toddlers with Down syndrome: Beyond the floor effect of Italian BSID–III scores

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ABSTRACT. La valutazione dello sviluppo delle abilità cognitive, linguistiche e motorie di bambini con sindrome di Down è spesso caratterizzata da profili piatti, con i punti di forza che sono oscurati dai predominanti punti di debolezza. Nel presente studio è stato indagato, su un campione di 144 bambini con sindrome di Down, un modo alternativo di convertire i punti grezzi in punti ponderati della *Bayley Scales of Infant and Toddlers Developmental–III (BSID–III*). I risultati hanno evidenziato due punti di forza: le abilità comunicative espressive e ricettive.

SUMMARY. Down syndrome is the most common genetic cause of intellectual disability but there are few studies on the development of toddlers with this syndrome. Considering the importance of early interventions aimed at improving the abilities of this population, the purpose of the present study is to assess the cognitive, language, and motor development of a group of 144 Italian toddlers with Down syndrome aged 12–36 months (individually matched for gender, chronological age, and parental education level with typical development toddlers) through the use of the Bayley Scales of Infant and Toddlers Development–III (BSID–III). The assessment of cognitive, language, and motor development of people with low abilities is far from being easy because it is very frequent to find flat profiles, where strengths are obscured and weaknesses are predominant. So, an alternative method of converting raw scores to weighted scores was used to overcome the floor effect of BSID–III scores. Results showed an increase in cognitive and communicative delay evident as early as the second and third years of age and a developmental profile of toddlers with DS characterized by strengths in expressive and receptive communication skills. Results were discussed in reference to the literature in recent years.

Keywords: *Down syndrome, BSID–III, Cognitive development, Language development, Motor development, Toddlers*

INTRODUCTION

Down syndrome (DS) is the most common genetic cause of intellectual disability and it is a clinical manifestation of chromosome abnormality, known as trisomy 21, which is characterized by a range of physical, intellectual, and clinical symptoms (Contestabile, Benfenati & Gasparini, 2010; Ferreira–Vasques & Lamônica, 2015; Grieco, Pulsifer, Seligsohn, Skotko & Schwartz, 2015; Roizen & Patterson, 2003). Despite several individual differences (Ferreira–Vasques & Lamônica, 2015; Karmiloff–Smith et al., 2016; Roizen & Patterson, 2003), the literature points to an atypical general development profile, involving cognitive, language, motor, self–care and personal–social domains (de Lima Freire, de Melo, Hazin & Lyra, 2014; Ferreira–Vasques & Lamônica, 2015; Karmiloff–Smith et al., 2016 Roizen & Patterson, 2003). The cognitive profile of DS population is characterized by an IQ between 30 and 70 with a mild to severe delay and which seems to increase with age (Aoki, Yamauchi & Hashimoto, 2018; Godfrey & Lee, 2018; Grieco et al., 2015; Karmiloff–Smith et al., 2016; Patterson, Rapsey & Glue, 2013; Robert & Richmond, 2015; Wester Oxelgren et al., 2018; Yang, Conners & Merrill, 2014).

Although DS has been extensively studied in the past, what we know about the syndrome mainly concerns the adult population, while there are few studies on samples of school–age children, particularly pre–school children (Karmiloff–Smith et al., 2016; Grieco et al., 2015; Naranajo & Robles–Bello, 2020; Needham, Nelson, Short, Daunhauer & Fidler, 2021; Patterson et al., 2013). For what concern cognitive development of toddlers with DS, Milojevich and Lukowski (2016) suggested the presence of cognitive delay as early as preschool age. In agreement with this study a longitudinal research by Aoki et al. (2018) suggested that cognitive, language, and motor developmental delays are evident as early as preschool age and consist of a slower rate of development in children with DS than that in children with typical development (TD).

Concerning language development delay, it would become more evident with the onset of the complex language acquisition phase (Abbeduto, Warren & Conners, 2007; Levy & Eilam 2013). Furthermore, non–verbal communication skills and receptive language would be less compromised than expressive language. (Abbeduto et al., 2007; Bello, Onofrio & Caselli, 2014; Caselli et al., 1998; Eggers & Van Eerdenbrugh, 2018; Ferreira–Vasques & Lamônica, 2015; Galeote, Sebastian, Checa, Rey & Soto, 2011; te Kaat-van den Os, Volman, Jongmans & Lauteslager, 2017; Mason–Apps, Stojanovik, Houston–Price, Seager & Buckley, 2020; Næss, Lyster, Hulme & Melby–Lervåg, 2011; Patterson et al., 2013; te Kaat–van den Os, Jongmans, Volman & Lauteslager, 2015; Witecy & Penke, 2017; Zampini & D'Odorico, 2011).

Regarding motor skills, the developmental trajectories of fine and gross motor skills of children with DS are similar to children with typical development, but progress is much slower (Aoki et al., 2018; Cardoso, de Campos, Dos Santos, Santos & Rocha, 2015; Ferreira–Vasques & Lamônica, 2015; Kim, Kim, Kim, Jeon & Jung, 2017; Malak, Kostiukow, Krawczyk–Wasielewska, Mojs & Samborski, 2015; Tudella, Pereira, Basso & Savelsbergh, 2011). DS is characterized by a general impairment in motor skills with difficulties in motor planning and coordination, difficulties in fine motor skills, and a delay in achieving developmental milestones (Alesi & Battaglia, 2019; Ferreira–Vasques & Lamônica, 2015; Frank & Esbensen, 2015). A recent systematic review by Needham et al. (2021), with the aim of analyzing early developmental characteristics of fine–motor skills in children with Down syndrome, revealed important individual differences in the development of these skills that, combined with the low number of studies present in literature, makes further research necessary to obtain more complete information about developmental trajectories and to plan appropriate interventions (Needham et al., 2021).

The most commonly used standardized instrument for the assessment of the development of toddlers aged between 0 and 42 months is the *Bayley Scales of Infant and Toddlers Development – Third Edition* (*BSID–III*; Bayley, 2006; Italian adaptation by Ferri, Orsini, Rea, Stoppa & Mascellani, 2015). This instrument is widely used in clinical settings to identify young children with developmental delay and to assist the specialist in intervention planning. However, few studies in literature used the BSID–III to investigate clinical populations and only some scales of BSID–III often are used (i.e. Cardoso et al., 2015). This, perhaps, because the American BSID–III (Bayley, 2006) tends to underestimate developmental deficits due to the mixed sample used for the standardization of the instrument (characterized not only by toddlers with typical development but also by premature toddlers, toddlers with Down syndrome, cerebral palsy, pervasive developmental disorders, language disorder and toddlers with atypical developmental risks), which leads to lower normative averages, increased standard deviation scores and

decreased accuracy of the assessment (Anderson & Burnett, 2017). In contrast, the Italian normative sample of BSID–III (Ferri et al., 2015) is characterized entirely by children with typical development and this could explain the flattening of the Italian BSID–III scores (Ferri, Carleschi, Mascellani, Coatti & Stoppa, 2005), a fairly common issue when using standardized instruments to assess clinical populations (i.e. Laghi et al., 2022; Pezzuti et al., 2018). However, the BSID–III scales also show some strengths, as they allow to assess toddler's functioning through direct observation of his/her behavior and to draw up a developmental profile characterized by possible strengths and weaknesses, which is essential for planning personalized interventions, focused on the real needs of children (Ferri et al., 2015).

The literature states that we are far from being able to delineate a typical developmental profile of DS: we can describe a general impairment, but how the delay is manifested, at different stages of development and within different developmental domains, is still a debated issue (Karmiloff–Smith et al., 2016; Needham et al., 2021; Patterson et al., 2013). So, given the small number of studies on the developmental characteristics of DS toddlers and the importance of early intervention to improve the development and quality of life of this population, the main objective of the present study is to investigate the cognitive, language, and motor development of toddlers with DS aged 12–36 months, assessed by the Italian version of the *Bayley Scales of Infant Development – Third Edition* (*BSID–III*; Ferri et al., 2015). To overcome the floor effect of BSID–III scores, an alternative method of converting raw scores to weighted scores proposed by Hessl et al. (2009) and extended by Orsini, Pezzuti and Hulbert (2015) was used, which recovered intra– and inter–individual variability in scores.

The present study attempts to test the following hypotheses:

1. Since the literature has shown that developmental delay increase with age, (Aoki et al., 2018; Grieco et al., 2015; Patterson et al., 2013), we assume that this can also be observed in the first three years of life, assuming BSID–III scores of DS toddlers aged 12–24 months to be higher than those obtained by DS toddlers aged 25–36 months.
2. The developmental profile of toddlers with DS could be characterized not only by deficits and weaknesses, but also by strengths, which could be identified in gestural communication skills and comprehension language (Abbeduto et al., 2007; Mason–Apps et al., 2020).

MATERIALS AND METHODS

Participants

Participants were recruited from the Italian Association of Down People of Rome Onlus (Associazione Italiana Persone Down, AIPD, Roma Onlus) and parents of toddlers gave their authorization through an informed consent process. The clinical group included 144 Italian full–term toddlers with DS diagnosis (82 males and 62 females), without serious health problems (i.e. leukemia and heart disease requiring surgery) aged 12–36 months (Mean = 23.98, *SD* = 7.35). They were compared with a group of toddlers with typical development (TD; Control Group), who were part of the Italian BSID–III standardization sample, individually matched for gender, chronological age, and years of education parents (we consider the higher number of years of education between the two parents) (see Table 1). So, the two groups (*DS* and TD) included the same numbers of males and females and they were perfectly matched for age in months and days (Mean $age_{Down\ group}$ = 23.98, *SD* $age_{Down\ group}$ = 7.35; Mean $age_{Control\ group}$ = 24.01, *SD* $age_{Control\ group}$ = 7.27; $t_{(286)} = .035$, $p = .972$, Cohen's $d = .00$) and years of education parents (Mean $edu_{Down\ group}$ = 15.33, *SD* $edu_{Down\ group}$ = 2.57; Mean $edu_{Control\ group}$ = 15.33, *SD* $edu_{Control\ group}$ = 2.57; $t_{(286)} = .000$, $p = 1.000$ Cohen's $d = .00$). The full sample was divided into two age groups to observe any developmental differences between 2nd year (12–24 months) and 3rd year (25–36 months) of life. The study was approved by the local ethical committee at Sapienza University of Rome.

Instrument

– *Bayley Scales of Infant and Toddlers Development – Third Edition* (*BSID–III*; Bayley, 2006; Italian adaptation by Ferri et al., 2015). The Italian standardization of BSID–III was carried out on a sample of 1,050 typically developing toddlers (544 males and 506 females) aged between 12 months and 15 days and 42 months and 14 days (Ferri et al., 2015). The psychometric reliability of the five subscales of the Italian BSID–III (Cognitive, Expressive communication, Receptive communication, Fine–motor, and Gross–motor subscales) vary between .87 (Fine–motor) and .94 (Expressive communication). The reliability

Table 1 – Sample size, mean, and standard deviation of age and parental education of TD and DS groups and gender groups

Groups		Age (months)		Parental education (years)	
	N	*M*	*SD*	*M*	*SD*
Total toddlers with TD	144	24.01	7.28	15.33	2.57
Females with TD	62	24.37	6.97	15.50	2.52
Males with TD	82	23.74	7.53	15.20	2.62
Total toddlers with DS	144	23.98	7.35	15.33	2.57
Females with DS	62	24.39	6.99	15.42	2.52
Males with DS	82	23.68	7.64	15.26	2.62

of composite scores varies between .94 (Linguistic composite scores) and .92 (Motor composite scores). These values were similar to the USA standardizations.

The Italian BSID–III test results are expressed through standardized cognitive, language, and motor development scores with a mean of 10 and a standard deviation of 3. Because of the global developmental delay that is typical of toddlers with DS, we started the BSID–III test with the items that were usually appropriate for children younger than the chronological age of our subjects (Ferri et al., 2005).

Data analysis

– *BSID–III traditional weighted scores*. We computed *t*-tests for the independent groups and the standard differences (i.e., effect sizes) to compare clinical and control groups on each dependent variable of BSID–III and, to compare age–groups, separately, for DS and TD groups. The effect size (e.g. Cohen's d) and statistical significance (*p*–value) are reported. For the interpretation of Cohen's *d*, we used Hyde's (2005) guidelines: small effect (.11<*d*<.35); moderate effect (.36 <*d*<.65), large effect for (.66<*d*<1.00), or very large effect (*d*>1.00). Repeated measures ANOVA tests (with η^2 as a measure of effect size: .01 small effect, .06 medium effect and .14 for large effect) with Bonferroni correction are calculated in order to compare the subjects within the clinical group with DS and TD group on 5 BSID–III subscales, separately.

– N*ew weighted scores* (Hessl et al., 2009; Orsini et al., 2015). Using the method proposed by Hessl et al. (2009) and extended by Orsini et al. (2015), the raw scores of subtests, obtained by the group with DS, that correspond to a weighted score (ws) of 1 were transformed into z–points using means and standard deviations of the raw scores of the subtests for each age group. All other weighted scores higher than 1 were transformed into z–points using the inverse formula of their composition in the standardization process: $z = (ws - 10)/3$. In this way, the resulting measures of the weighted scores are expressed in *Z* scores, and therefore, the floor effect presented by a minimum score of 1 was overcome. For more detailed information about this statistical method, see Orsini et al. (2015) and Pezzuti et al. (2018). For example, a toddler of 24 months of age gets the raw scores reported in column A of Table 2 to the 5 BSID–III subscales (Cognitive, Expressive, Receptive, Fine–motor and Gross–motor). Using the traditional method, such raw scores would be all converted to a weighted score of 1 (see column B) corresponding to a normalized *z* point of −3 (see column C); conversely, using the means and standard deviations of the age–relevant reference sample of the subject (see column D), the new *z* points and new weights score are lower (see column E and F respectively)

Table 2 – Example of computing new standard scores on data of toddlers of 24 months s of age

	A	B	C	D	E	F
Subscales	Raw score (x)	Range of raw score corresponding to a weighted score (ws) of 1	z normalize d scores = (ws – 10)/3	Mean (M) and standard deviation (SD) of the raw scores of the subtests on group of 24 months of age (N = 1050)	z new points (zn) with Orsini et al. (2015) method: $z = (x – M)/SD$	New weighted scores (zn*3)+10
Cognitive	45	0–45	–3	64.0 (6.8)	–2.79	–8
Receptive	13	0–13	–3	29.0 (4.3)	–3.72	–1
Expressive	2	0–16	–3	28.0 (5.8)	–4.48	–3
Fine–motor	20	0–31	–3	40.0 (3.0)	–6.67	–10
Gross–motor	35	0–45	–3	57.0 (3.5)	–6.29	–9

and we can reasonably conclude that the most impaired abilities in this toddler are motor skills.

We computed t-tests for the independent groups and the standard differences (i.e., effect sizes) to compare the age in the group with DS, and repeated measures ANOVA tests (with η^2 as a measure of effect size) with Bonferroni correction are calculated in order to compare the subjects within the clinical group with DS on 5 BSID–III subscales.

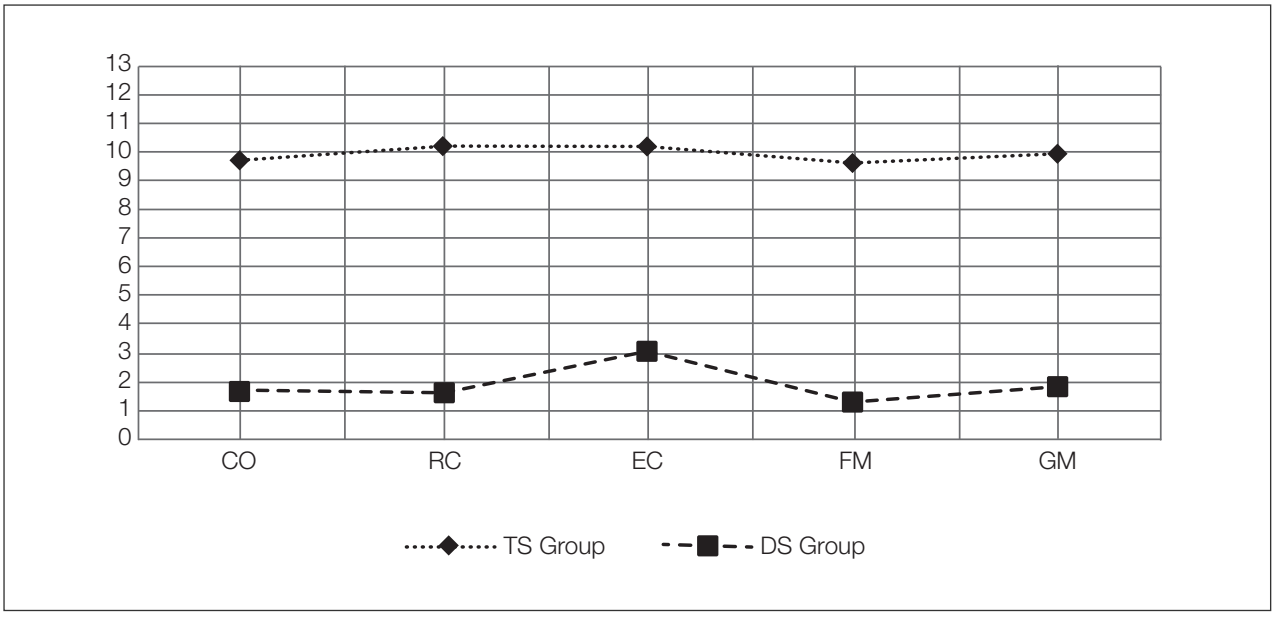
RESULTS

– *Results using the traditional BSID–III method of converting raw scores into weighted scores (traditional method)*. In comparison with the Typical Development (TD) group (n = 144), the Down syndrome (DS) group (n = 144) had considerably lower traditional weighted scores in all measures of BSID–III (see Table A in Supplementary material and Figure 1).

We then compared the scores of each BSID–III measure with the other four measures in the DS group. The ANOVA effect–sizes (η^2) of results reported in Table 3 show a large effect (η^2 >.14) for the following comparisons: Cognitive and Expressive communication subscales with the first tending to be lower; Receptive communication and Expressive communication subscales with the former tending to be lower; Expressive communication and Fine–motor subscales with the former tending to be higher. A medium effect (.06<η^2<.14) emerged for the comparison of Expressive communication and Gross–motor subscales with the former tending to be higher. In sum, for the group with DS the Expressive communication subscale tends to be higher than other ones, while Fine–motor subscales tend to be lower than Expressive communication.

Table B (reported in Supplementary material) and Figure 2 show the comparison between two age cohorts in all BSID–III subscales for both the TD and DS groups. In particular, the results highlight: a higher score for the TD group aged 12–24 months than for the TD group aged 25–36 months on the Gross–motor (GM) subscale; and a

Figure 1 – BSID–III profiles of DS and TD groups using traditional weighted scores



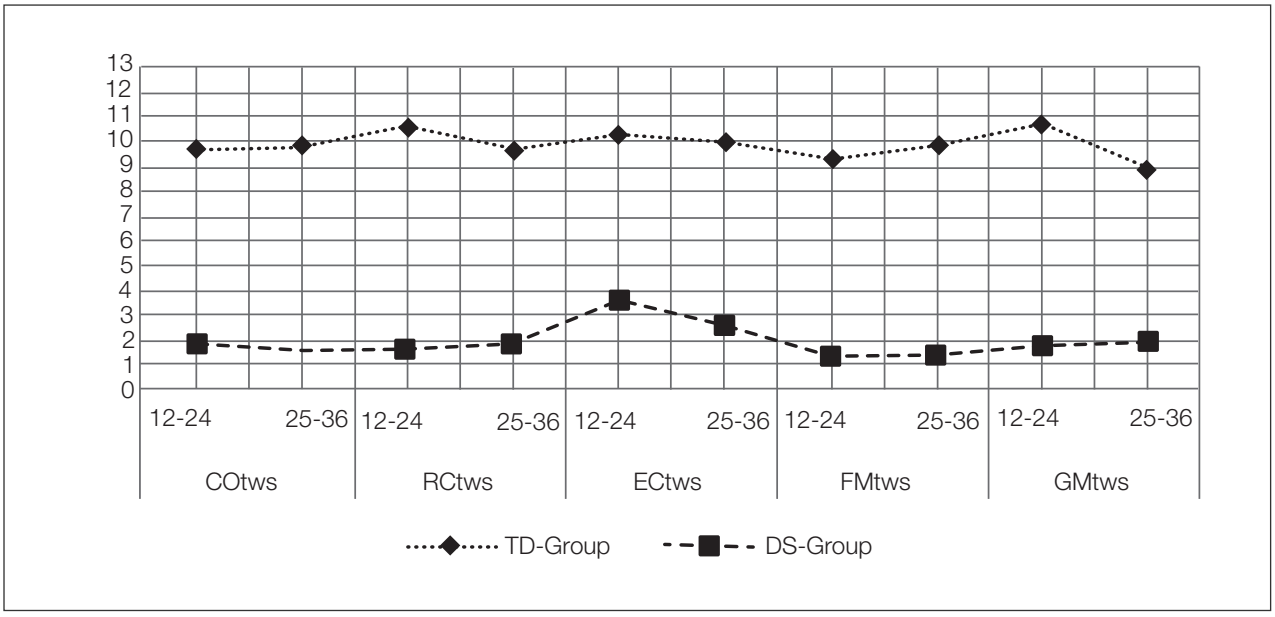
Legenda. CO = Cognitive scale; RC = Receptive communication; EC = Expressive communication; FM = Fine–motor; GM = Gross–motor.

Table 3 – Profiles of the group with DS: comparisons between pairs of five BDSI–III scales using traditional weighted scores

Comparison between pairs of 5 BSID–III subscales	[1]		[2]		Repeated measures Anova test and group mean comparisons			
	M_1	SD_1	M_2	SD_2	*Diff.*	$F_{(1,143)}$	*P*	η^2
$CO_{[1]}$ *vs* $RC_{[2]}$	1.68	1.21	1.63	1.18	.05	.23	.630	.04
$CO_{[1]}$ *vs* $EC_{[2]}$	1.68	1.21	3.03	1.58	−1.35	96.17	<.001	.19
$CO_{[1]}$ *vs* $FM_{[2]}$	1.68	1.21	1.31	.81	.37	11.85	<.001	.03
$CO_{[1]}$ *vs* $GM_{[2]}$	1.68	1.21	1.81	1.52	−.13	.88	.349	.00
$RC_{[1]}$ *vs* $EC_{[2]}$	1.63	1.18	3.03	1.58	−1.40	97.75	<.001	.20
$RC_{[1]}$ *vs* $FM_{[2]}$	1.63	1.18	1.31	.81	.32	9.33	.003	.02
$RC_{[1]}$ *vs* $GM_{[2]}$	1.63	1.18	1.81	1.52	−.17	1.48	.226	.00
$EC_{[1]}$ *vs* $FM_{[2]}$	3.03	1.58	1.31	.81	1.72	144.48	<.001	.32
$EC_{[1]}$ *vs* $GM_{[2]}$	3.03	1.58	1.81	1.52	1.22	59.98	<.001	.13
$FM_{[1]}$ *vs* $GM_{[2]}$	1.31	.81	1.81	1.52	−.49	14.22	<.001	.04

Legenda. CO = Cognitive scale; RC = Receptive communication scale; EC = Expressive communication scale; FM = Fine–motor scale; GM = Gross–motor scale.

Figure 2 – BSID–III age–profiles of DS and TD groups using traditional weighted scores (tws)



Legenda. CO = Cognitive scale; RC = Receptive communication; EC = Expressive communication; FM = Fine–motor; GM = Gross–motor.

higher score for the children with DS aged 12–24 months than for the group with DS aged 25–36 months on the Expressive communication (EC) subscale.

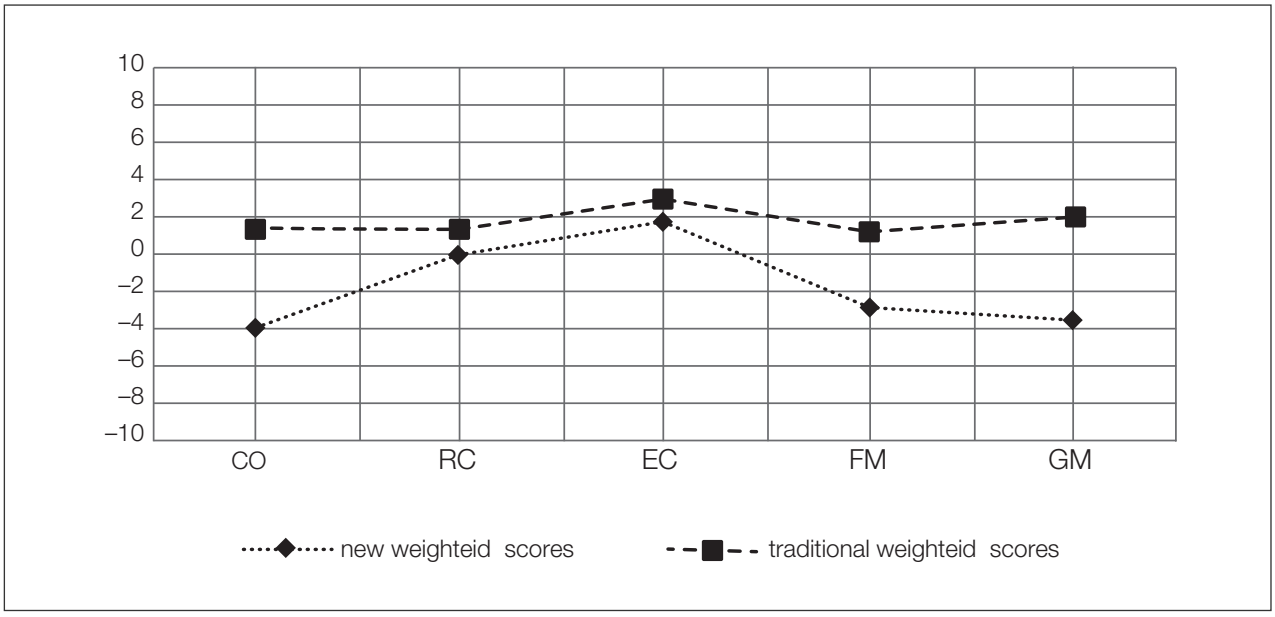
– *Results with an alternative method of converting raw scores into weighted scores (Hessl et al., 2009; Orsini et al., 2015).* Using the traditional transformation of the raw scores according to the conversion tables of the BSID–III Italian standardization (Ferri et al., 2015), a very high percentage of subtests with a weighted score of 1 at the five BSID–III subscales, occurred in the sample. In details, there were subscales that, more than others, had a weighted score of 1, such as Fine–motor (84.0%), followed by Receptive communication (68.8%), Gross–motor (69.4%), Cognitive (69.4%), and Expressive communication (25.0%).

  Thus, a second and new transformation of the raw scores was performed using the method proposed by Hessl et al. (2009) and extended by Orsini et al. (2015), following the steps shown in Table 2. Figures A–E reported in Supplementary material show the weighted scores according to the two methods (traditional and new transformation) for the sample of 144 toddlers on the five BSID–III subscales. Compared with the traditional method, the new method increased intra– and inter–individual variability of scores.

– *Results of the study of BSID–III profiles using the new method on DS sample*. Figure 3 shows the BSID–III profiles of the DS sample with two kinds of scores and while the profile of the traditional weighted scores is fairly flat, the profile of the new weighted scores shows more variability between the five BSID–III measures, highlighting strengths (e.g. in EC and RC) and weaknesses (e.g. in CO and GM).

  From repeated measures ANOVA tests on new weighted scores (see Table 4), to compare all scores of each measure with the other four BSID–III measures, a medium ($.06<\eta^2<.14$) and large ($\eta^2>.14$) effect emerged for the following comparisons between: Cognitive and Receptive communication subscales with the former subscale tends to be lower; Expressive communication and Cognitive subscales with the former tends to be higher; Receptive communication and Expressive communication

Figure 3 – BSID–III profiles of DS sample with two kinds of scores



Legenda. CO = Cognitive scale; RC = Receptive communication; EC = Expressive communication; FM = Fine–motor; GM = Gross–motor.

Table 4 – Profile of DS: comparisons between pairs of the five BSID–III subscales using new weighted scores

Comparison between pairs of 5 BSID–III subscales	[1]		[2]		Repeated measures Anova test and group mean comparisons			
	M_1	SD_1	M_2	SD_2	*Diff.*	$F_{(1,143)}$	*p*	η^2
$CO_{[1]}$ *vs* $RC_{[2]}$	–3.80	6.20	–.25	3.07	–3.55	79.5	<.001	.12
$CO_{[1]}$ *vs* $EC_{[2]}$	–3.80	6.20	2.01	3.61	–5.81	152.04	<.001	.25
$CO_{[1]}$ *vs* $FM_{[2]}$	–3.80	6.20	–2.43	4.36	–1.37	7.49	.007	.02
$CO_{[1]}$ *vs* $GM_{[2]}$	–3.80	6.20	–3.75	6.23	–.05	.01	.927	.00
$RC_{[1]}$ *vs* $EC_{[2]}$	–.25	3.07	2.01	3.61	–2.26	66.00	<.001	.10
$RC_{[1]}$ *vs* $FM_{[2]}$	–.25	3.07	–2.43	4.36	2.18	34.11	<.001	.08
$RC_{[1]}$ *vs* $GM_{[2]}$	–.24	3.07	–3.75	6.23	3.51	54.36	<.001	.11
$EC_{[1]}$ *vs* $FM_{[2]}$	2.05	3.58	–2.43	4.36	4.49	96.06	<.001	.24
$EC_{[1]}$ *vs* $GM_{[2]}$	2.05	3.58	–3.75	6.23	5.81	122.04	<.001	.24
$FM_{[1]}$ *vs* $GM_{[2]}$	–2.43	4.36	–3.75	6.23	1.32	6.00	.016	.01

Legenda. CO = Cognitive scale; RC = Receptive communication scale; EC = Expressive communication scale; FM = Fine–motor scale; GM = Gross–motor scale.

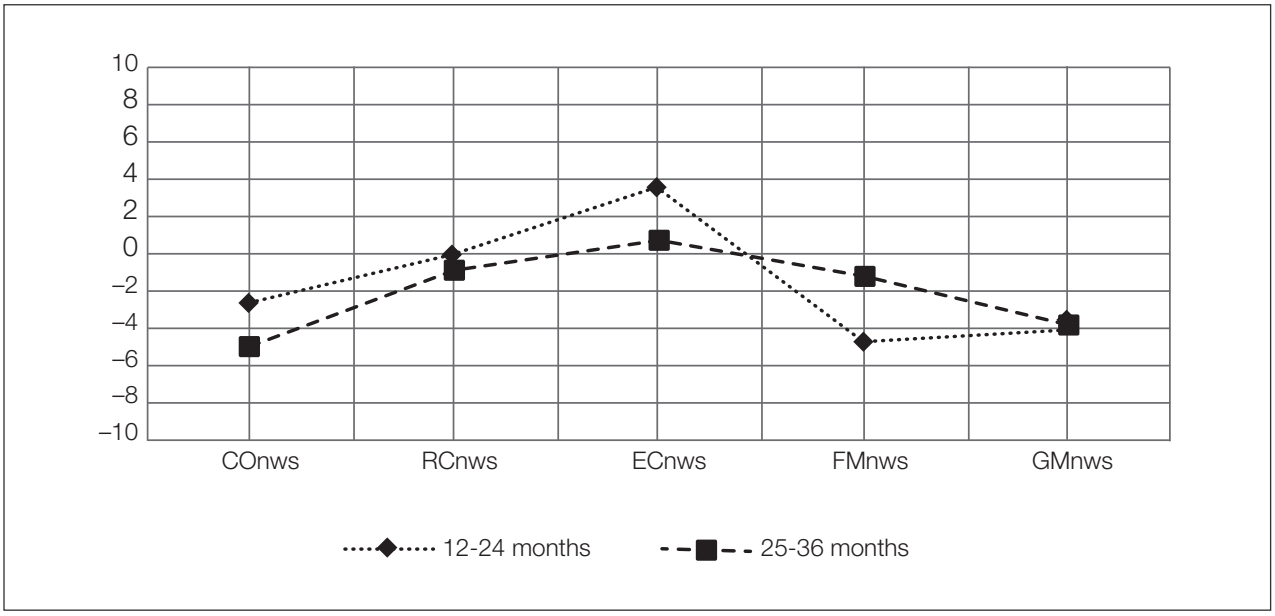
subscales with the former tends to be lower; Receptive communication and Fine–motor subscales with the former tends to be higher; Receptive communication and Gross–motor subscales with the former tends to be higher; Expressive communication and Fine–motor subscales with the former subscales tends to be higher; and Expressive communication and Gross–motor subscales with the former tends to be higher. In summary, in the DS sample using the new weighted scores, Expressive and Receptive communication subscales tend to be higher than Cognitive, Fine–motor, and Gross–motor subscales. Table C reported in Supplementary material and Figure 4 show the comparisons of five BSID–III measures between two age groups with DS using new weighted scores. There was a significant difference between the two age groups of children with DS in the Expressive communication subscale where scores of children with DS aged 12–24 months were higher than those of older children. In contrast, the statistically significant difference by age in the Fine–motor subscale highlights lower performance at 12–24 months than in the 25–36 months range There is also a small effect of age on the Cognitive subscale, with the score of toddlers aged 12–24 months slightly higher than toddlers aged 25–36 months. No age effects for the Gross–motor subscale were observed.

DISCUSSION

Down syndrome is characterized by an atypical pattern of development of processes involving cognitive, language, motor, self–care, and personal–social domains (Ferreira–Vasquez & Lamonica 2015; de Lima Freire et al., 2014; Karmiloff–Smith et al., 2016). The aim of this study is to investigate the cognitive, linguistic, and motor development of toddlers with DS assessed by BSID–III in order to give a contribution to the study of the developmental features of these toddlers in their early years of life.

Although the use of BSID–III scales presents some limitations with samples with developmental delays (Anderson & Burnett, 2017; Ferri et al., 2005), they are well suited to outlining a profile characterized by strengths and

Figure 4 – BSID–III profiles of two age groups using new weighted scores



Legenda. CO = Cognitive scale; RC = Receptive communication; EC = Expressive communication; FM = Fine–motor; GM = Gross–motor.

weaknesses. This is necessary for the customization of early clinical intervention, through direct monitoring of the toddlers' behavior, and the involvement of parents who are important sources of additional information. The present study suggests the use of an alternative psychometric method of converting raw scores into weighted ones, in order to overcome the limitation of the floor effect that occurs when we use the Italian version of the BSID–III scales with samples with intellectual disabilities.

Comparing toddlers with DS to the TD group, using the traditional BSID–III conversion method, the results showed that the toddlers with DS achieve a significantly lower profile in each developmental domain than the TD group. Observation of the profile of the group with DS highlights a higher expressive communication score compared to the scores in the BSID–III other subscales. This result could be explained if we consider the nature of the items present in the Expressive communication subscale (EC). These items assess expressive general communication, which include not only verbal skills but also pre–verbal and gestural skills, defined as a strength in toddlers with DS (Abbeduto et al., 2007; te Kaat–van den Os et al., 2017). Although, as the administration of BSID–III items proceeds, those items assess increasing complex skills, following the acquisition time of typical development toddlers. So, the first EC items assess gestural, non–verbal, and pre–verbal communication skills. Then, they gradually tend to focus on increasingly complex verbal language skills. This could explain the lower score obtained by DS toddlers aged 24–36 months than by DS toddlers aged 12–24 months, in agreement with the literature that suggests that the difficulties in language development of children with DS are more evident when the verbal language acquisition phase begins (Abbeduto et al., 2007; Levy & Eilam 2013).

Therefore, with the exception of the scores obtained by the youngest toddlers with DS on the Expressive communication subscale, the results showed a general flattening of the scores that returns a flat profile of development. Thus, the method of converting raw scores to weighted scores proposed by Hessl et al. (2009) and extended by Orsini et al. (2015) was adopted. Results with new weighted scores showed that this method retrieves the individual variability of the scores obtained on the BSID–III scales and outlines a developmental profile characterized not only by deficits but also by potential strengths of toddlers with DS. Therefore, in agreement with literature, which emphasize that receptive communication skills, along with gestural and pre–verbal ones are less impaired than other skills in children with DS (Abbeduto et al., 2007; Bello et al., 2014; Caselli et al., 1998; Eggers & Van Eerdenbrugh, 2018; Ferreira–Vasques & Lamônica, 2015; Galeote et al., 2011; Næss et al., 2011; Patterson et al., 2013; te Kaat–van den Os et al., 2015; te Kaat–van den Os et al., 2017; Witecy & Penke, 2017; Zampini & D'Odorico 2011), the results showed that toddlers with DS obtain higher scores on both the Expressive and Receptive communication subscales than on Cognitive and Motor subscales. Thus, these findings suggest that in the earliest years of the life of toddlers with DS, pre–verbal and receptive communication skills may be strengths in their development. Since an important positive correlation between use of pre–verbal, gestural communication, and later vocabulary development (Caselli et al., 1998; Roberts, Price & Malkin, 2007; Yoder & Warren, 2004; Yoder, Woynaroski, Fey & Warren, 2014), has been highlighted, these results support the importance of maintaining and reinforcing pre–verbal communication skills at this developmental stage in toddlers with Down syndrome, which is also in line with what Yoder et al. (2014) revealed on the effectiveness of early communication interventions.

These findings could have important clinical implications because preschool children with DS often access intervention programs, provided by the Italian Health System, only after their second/third year of life, starting with psychomotor therapies. While access to language and communication therapies (typically speech therapy) occurs only after their third/fourth year of age. As already stated by Caselli et al. (1998) and Yoder et al. (2014), the development of intervention programs aimed at reinforcing communication skills before the age of 3 years is crucial, as it is possible to reduce delay in the acquisition of expressive language.

Another interesting result with the use of new weighted scores is that it hasn't shown a significant difference between Fine–motor and Gross–motor scores of toddlers with DS, suggesting a possible general impairment in the motor domain in toddlers with DS in the first three years of life. This seems in contrast with the literature that suggests a more impairment in fine–motor skills than gross–motor ones, however this difference was observed in studies with DS samples older than 36 months (i.e., Ferreira–Vasquez & Lamônica, 2015). A recent review by Needham et al. (2021), highlighted that there are few studies, in the literature, that analyze fine–motor skills in preschool children with DS and there are no studies aimed at analyzing the difference between fine–motor and gross–motor skills in toddlers with DS aged between 12 and

36 months. Fine–motor skills are very important to self–care, academic achievement, and everyday autonomy, so there is a need to deepen understanding of the impairment of fine–motor skills at this early stage of development in children with DS in order to improve early intervention programs (Alesi & Battaglia, 2019; Needham et al., 2021).

While there are no significant differences between the two age groups with DS on the Receptive communication and Gross–motor subscales, a small difference can be observed in the Cognitive subscale, with the score of toddlers with DS aged 25–36 months lower than the score of toddlers with DS aged 12–24 months. These results seem to be in line with the literature that considers mental delay to increase with age (Godfrey & Lee, 2018; Grieco et al., 2015; Karmiloff–Smith et al., 2016; Patterson et al., 2013; Robert & Richmond, 2015; Wester Oxelgren et al., 2019).

A statistically significant difference was observed between the scores of the two age groups with DS on the Expressive communication and Fine–motor subscales. In particular, the Expressive communication scores of the group with DS aged 25–36 months, were significantly lower than the score of toddlers of DS aged 12–24 months, confirming the results obtained with the traditional raw score conversion method. Instead, the group with DS aged 24–36 months had significantly higher scores than toddlers with DS aged 12–24 months on the Fine–motor scores, suggesting a possible decrease in the delay of fine–motor development, between the second and third year of life. This result is consistent with the study by Hauck, Felzer–Kim and Gwizdala (2020) that points out that the delay in fine–motor development would tend to decrease with age, highlighting that the gap between fine–motor development of children with DS and children with TD from 0 to 18 months would tend to narrow with age even though the speed of development is lower in children with DS. Our results, together with Hauck et al. (2020), could suggest that in the first 3 years of life fine–motor skills would increase in relation to age. Further research should therefore investigate the trajectories of fine–motor development in the first 3 years of life in order to plan rehabilitation interventions that support positive trends in the development of these skills.

In conclusion, this study makes an important contribution to the knowledge of what happens across developmental domains in toddlers with Down syndrome (DS) and highlights that the developmental profile of children with DS is not only characterized by delays or deficits, but also by resources and strengths that are essential for clinicians and researchers to identify appropriate early intervention. We know that, often, standardized scores return a flat profile when assessing the development of individuals with developmental delays. However, the method of Hessl et al. (2009) and Orsini et al. (2015) allows for more accurate research designs and greater understanding of the development of populations with developmental delay or intellectual disabilities, because it allows to capture intra– and inter–individual variability of scores, overcoming the floor effect.

Despite these appreciable results and implications, there are some limits to the present study. First, it is based on cross–sectional research so it necessitates caution in interpreting age related changes, which could be better captured by studies with follow up. Second, the study is limited to assessing the cognitive, linguistic and motor development of DS toddlers, but does not consider emotional and socio–adaptive behavior, so future research could also investigate this development domain to better define the global functioning profile. Third, our assessment of cognitive, language, and motor development is limited to the use of the BSID–III, so future research could compare the results to other development assessment instruments, to further investigate the validity of Hessl et al.'s (2009) and Orsini et al.'s (2015) method to overcome the issues of the floor effect.

Finally, future research could also use this alternative method of converting raw scores to weighted scores to better investigate the effectiveness of treatments, as the scores obtained may be more sensitive to change.

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SUPPLEMENTARY MATERIAL

Table A – Comparisons on five BSID-III subscales between DS and TD groups using traditional weighted scores

BSID-III subscaless	Group with DS (*n* = 144)		Group TD (*n* = 144)		*t*-test and group mean comparisons				
	M	*SD*	*M*	*SD*	*Diff.*	$t_{(286)}$	*p*	*Cohen d*	*95% CI*
Cognitive (CO)	1.68	1.21	9.71	2.78	−8.03	31.79	<.001	3.74	[−4.15, −3.38]
Receptive (RC)	1.63	1.18	10.20	2.83	−8.57	33.51	<.001	3.94	[−4.37, −3.57]
Expressive (EC)	3.03	1.59	10.16	2.87	−7.13	26.09	<.001	3.07	[−3.43, −2.75]
Fine-motor (FM)	1.31	.81	9.61	2.92	−8.30	32.86	<.001	3.86	[−4.28, −3.50]
Gross-motor (GM)	1.81	1.52	9.90	3.21	−8.09	27.32	<.001	3.21	[−3.59, −2.88]

Table B – Comparison of Five BSID-III measures between two age TD and DS groups using traditional weighted scores

	12-24 months (*n* = 72)		25-36 months (*n* = 72)		*t*-test and group mean comparisons				
TD group	*M*	*SD*	*M*	*SD*	*Diff.*	$t_{(142)}$	*p*	*Cohen d*	*95% CI*
Cognitive (CO)	9.64	3.19	9.78	2.31	−.14	.30	.765	.05	[−.28, .38]
Receptive (RC)	10.64	3.15	9.76	2.43	.88	1.87	.064	.31	[−.65, .02]
Expressive (EC)	10.25	3.29	10.07	2.40	.18	.38	.707	.06	[−.39, .27]
Fine-motor (FM)	9.35	2.97	9.88	2.87	−.53	1.08	.280	.18	[−.15, .51]
Gross-motor (GM)	10.74	3.28	9.06	2.94	1.68	3.24	<.001	.54	[−.88, −.21]
DS group									
Cognitive (CO)	1.79	1.16	1.57	1.25	.22	1.10	.272	.18	[−.52, .14]
Receptive (RC)	1.58	1.23	1.68	1.12	−.10	.50	.621	.08	[−.25, .41]
Expressive (EC)	3.60	1.54	2.46	1.44	1.14	4.59	<.001	.76	[−1.11, −.43]
Fine-motor (FM)	1.31	.74	1.32	.87	−.01	.10	.918	.02	[−0.31, .35]
Gross-motor (GM)	1.72	1.24	1.89	1.76	−1.17	.66	.513	.11	[−.22, .44]

Table C – Comparison of five BSID-III measures between two age groups with DS using new weighted scores

BSID–III subscales	Group with DS 12-24 months (*n*= 72)		Group with DS 25-36 months (*n* = 72)		*t*-test and group mean comparisons				
	M	*SD*	*M*	*SD*	*Diff.*	$t_{(142)}$	*p*	*Cohen d*	*95% CI*
Cognitive (CO)	–2.71	5.79	–4.89	6.44	2.18	2.13	.035	.35	[–.69, .03]
Receptive (RC)	.13	2.76	–.60	3.34	.73	1.43	.155	.24	[–.57, .09]
Expressive (EC)	3.55	1.67	.56	4.29	2.99	5.51	<.001	.91	[–1.27, –.58]
Fine–motor (FM)	–3.78	5.24	–1.09	2.69	2.69	3.88	<.001	.64	[.31, .99]
Gross–motor (GM)	–3.77	5.82	–3.74	6.65	.02	.02	.983	.00	[–.33, .33]

Figure A – BSID-III Cognitive subscale (CO)

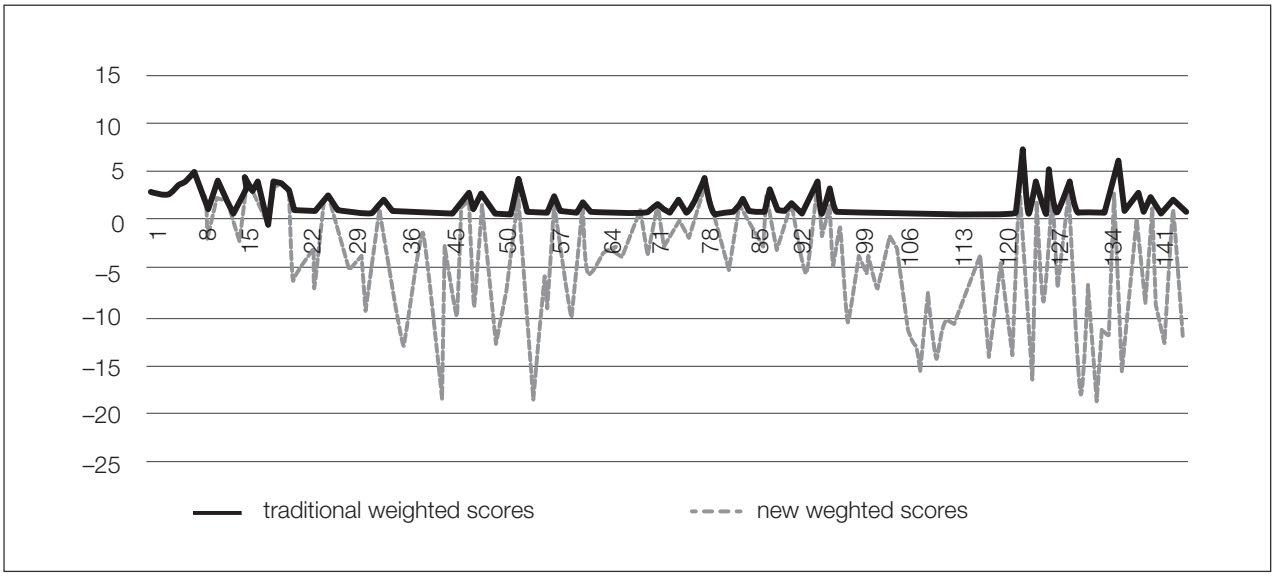


Figure B – BSID-III Receptive subscale (RC)

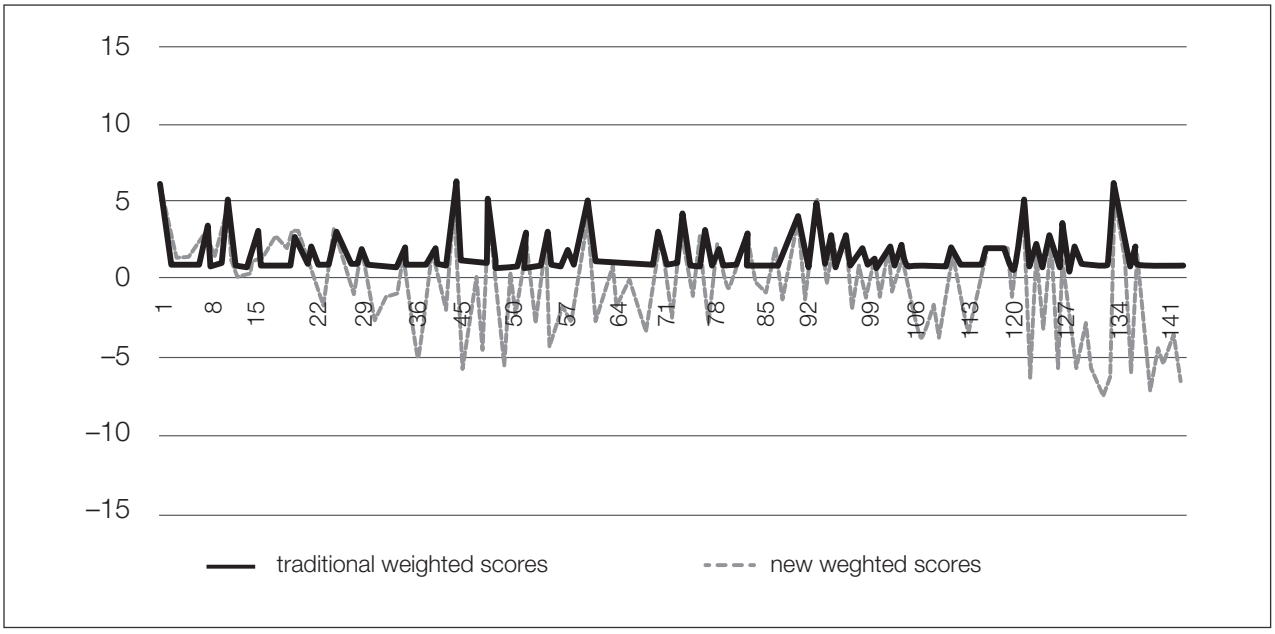


Figure C – BSID-III Expressive communication subscale (EC)

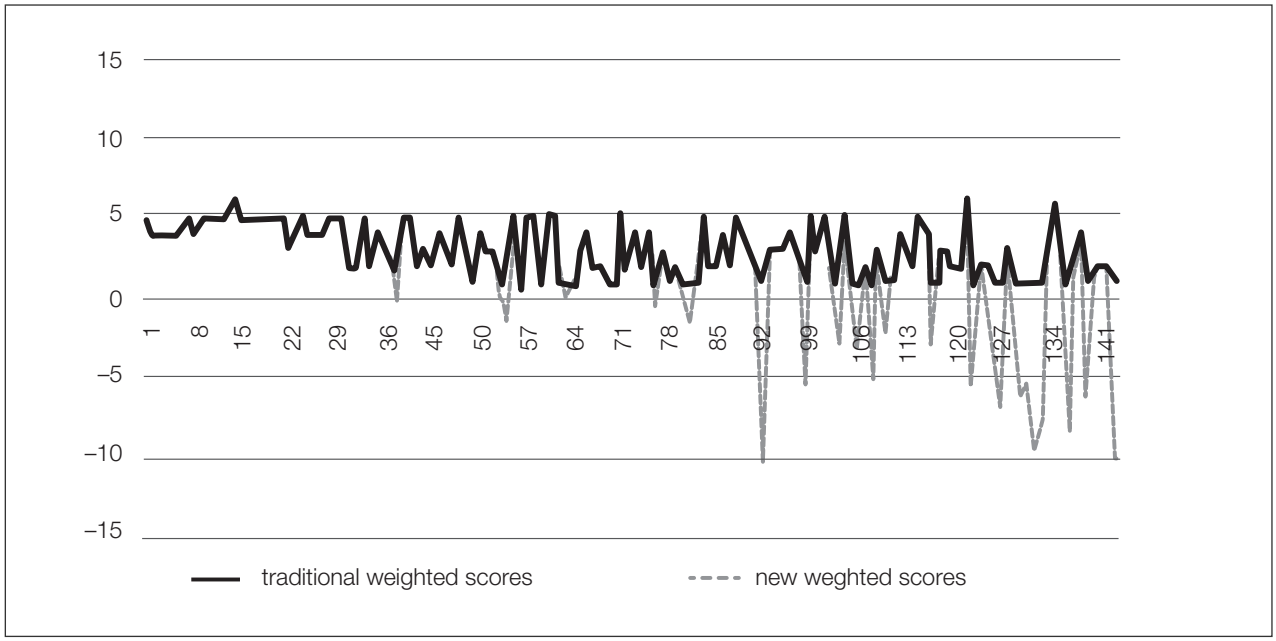
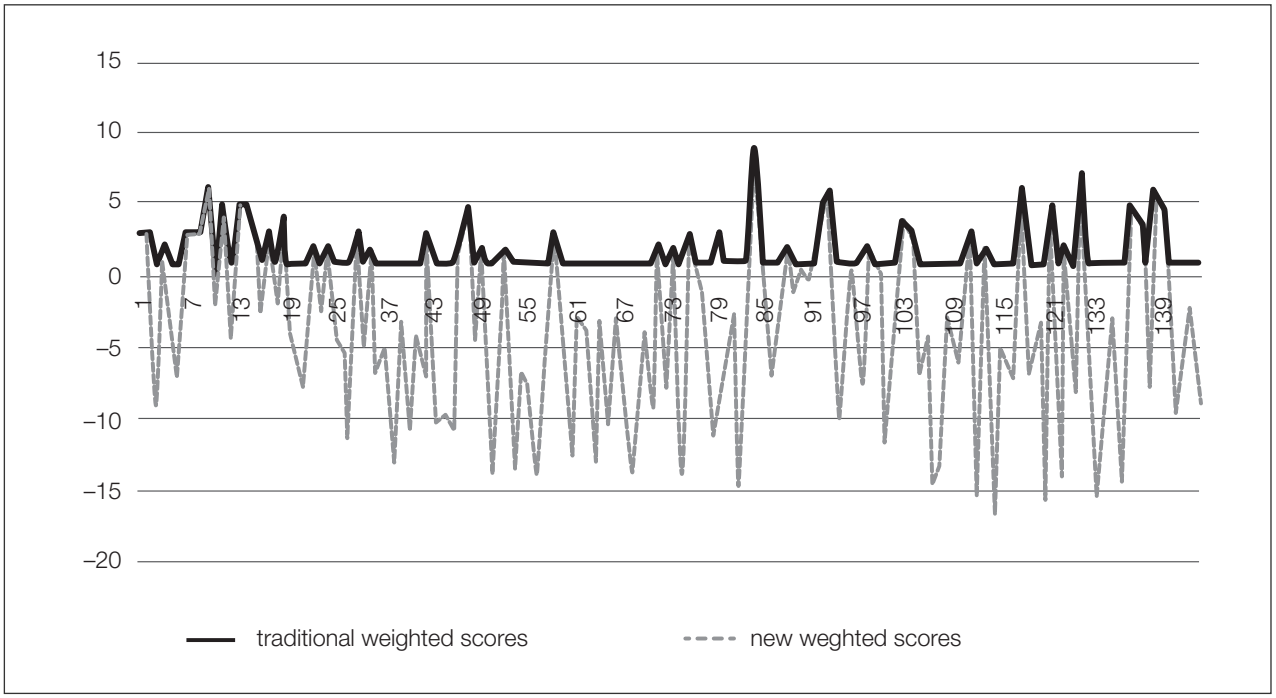


Figure D – BSID-III Fine-motor subscale (FM)

Figure E – BSID-III Gross-motor subscale (GM)



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Emotion dysregulation and ADHD subclinical manifestations in late adolescents: A study with a focus on inattention

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ABSTRACT. Il presente studio contribuisce alla letteratura volta ad indagare il legame tra la disregolazione emotiva da una parte e le problematiche di iperattività e disattenzione dall'altra, con un focus particolare sul funzionamento esecutivo come ponte tra i due aspetti. I risultati emergenti dall'analisi condotta su di un campione di tardo adolescenti (età media: 18,6 anni; 66% maschi) conferma la forte relazione tra le capacità di identificare, regolare, ed esprimere le emozioni e le componenti più rilevanti del Disturbo da Deficit di Attenzione/Iperattività (DDAI), specialmente in relazione ai deficit attentivi. Implicazioni per l'inquadramento e intervento clinico sono discusse, con particolare riferimento al mantenimento delle difficoltà attentive nel corso dell'età adulta.

SUMMARY. Recent influential approaches to this topic consider executive functions as a bridge between emotional dysregulation and hyperactivity/attention related disorders. Specifically, the ability to self-regulate emotions is viewed as a part of executive functions, which have a particular impact on attentional control. This study explored the relationships between self-reported attention disorders and emotional dysregulation in a sample of 132 non-clinical high school students (age: M = 18.6; SD = .71; 66% males). The research battery comprised four self-report measures which were individually administered to the participants: Brown Attention-Deficit Disorder Scales (Brown ADD Scales), Behavior Rating Inventory of Executive Function – Adult Version (BRIEF-A), Difficulties in Emotion Regulation Scale (DERS), Toronto Alexithymia Scale – 20 items (TAS). A series of regression analyses confirmed the stringent relation between the abilities to identify, regulate, and express emotions and the core variables involved in Attention Deficit Hyperactivity Disorder (ADHD), especially in relation to impairments in attentive functioning. Results throw light on the importance of emotion dysregulation in attention and executive control, suggesting the relevance of assessing the individual's abilities to manage affects to better conceptualize the disorder and plan interventions. Implications for research and practice are discussed especially in the context of psychological development and protraction of the condition during adulthood.

Keywords: *Attention deficit hyperactivity disorder, Emotional dysregulation, Adult attention-related issues, Executive functions*

INTRODUCTION

Difficulties in attention are found across different clinical conditions such as, for instance, bipolar disorders (Leibenluft, 2011) but are primarily involved in the Attention Deficit Hyperactivity Disorder (ADHD), a developmental and behaviorally-defined disorder, generally hereditary and characterized by several executive functions deficits (APA, 2013). As documented by research conducted in different countries, ADHD affects about 5-10% of the child population and persists into adulthood in 70% of cases (De la Barra, Vicente, Saldivia & Melipillan, 2013; Millstein, Wilens, Biederman & Spencer, 1997; Scahill & Schwab-Stone, 2000). ADHD is generally intended as a complex disorder, multifaceted and difficult to measure reliably (Hinshaw & Scheffler, 2018). Due to this complexity, some authors argue that actual diagnostic criteria are often not satisfactory, with the most accepted diagnostic systems (e.g., DSM-5) not adequately describing ADHD (Corbisiero, Stieglitz, Retz & Rösler, 2013). A first general reason for this controversial diagnostic status seems to be the overreliance on a categorical (rather than dimensional) diagnostic framework , which has been widely contested in contemporary psychological assessment literature for a variety of clinical entities such as, for instance, personality disorders (Gritti, Plouffe & Blanch, 2019; Widiger & Samuel, 2005). Of equal importance in the challenging ADHD diagnostic definition is the fact that common diagnostic models disregard a potentially key clinical feature, specifically emotion regulation impairment, which seems decisive also in the persistence of ADHD to adult age (Barkley & Fischer, 2010; Corbisiero et al., 2013).

Given contemporary models of ADHD stressing its relevance well beyond childhood (Barkley, Fischer, Smallish & Fletcher, 2002; Brown, 2013), it is of primary importance to investigate the mechanisms at play in key developmental ages such as late adolescence, and the changes that can take place in potential subclinical manifestations of ADHD. Multiple evidence shows, in fact, that the components of impulsivity and hyperactivity tend to recede or drastically change with maturation, for instance taking more subtle and socially acceptable forms, whereas deficits in emotional regulation tend to persist and sustain the concurrent and later impairments observed in adults with ADHD (Barkley, 2014; Ramsay, 2014) a lifespan perspective. The present study focuses on late adolescent period as a fundamental developmental stage where salient changes in psychological functioning, including emotional regulation and attention abilities, can take place, and difficulties in regulating emotions are considered particularly important to predict later social impairment in individuals with persistent ADHD (Bunford, Evans & Langberg, 2018). Importantly, given that hyperactivity symptoms generally tend to diminish over time whereas the inattentive component is particularly problematic for adult individuals with ADHD (APA, 2013), in this study enphasis is given to the (sublinical) manifestation of ADHD with a predominant inattentive presentation (named ADD hereafter). Finally, as will be detailed further in the next sections, in the present work a dimensional standpoint will be used in order to examine the relationships between emotion dysregulation, ADHD symptoms, and attention problems in particular.

From a categorical to a dimensional perspective in ADHD

A main factor in the difficulty in attaining a consensual definition of ADHD has been the overreliance on a categorical diagnostic definition even though the status of such a discrete entity has been challenged (Koziol & Stevens, 2012; Marcus, Norris & Coccaro, 2012; McLennan, 2016). Consistently with other psychopathological diagnoses, the description of discontinuous phenomena (vs dimensional description) is limited to external symptoms and has no explanatory power. Therefore, when clinicians state that a patient has ADHD (or is affected by another given disorder), but they rely on a controversial diagnostic category, they tend to reify that category itself with its contradictions (Hyman, 2010). In other words, this means that they may turn a psychological set of subjective and objective symptoms into something that might not exist in the real world.

Two main reasons support a paradigm shift in ADHD diagnosis towards a dimensional model: firstly, theoretical frameworks, diagnostic models, and clinical practice provide support that dimensional traits are more reliable for the description of psychopathological entities rather than categories (Clarkin & Livesley, 2016; Coghill & Sonuga-Barke, 2012). Evidence from different fields (e.g., behavioral genetics, neurobiology, clinical psychology, and neuropsychology) has supported the conceptualization of ADHD as an extreme on a continuum (Whitely, 2015). For

instance, some authors suggested that symptoms (such as impulsivity) can be identified, but neuropsychological tests can estimate only their severity. Though similar symptoms differ among people (Aragues, Jurado, Quinto & Rubio, 2011; Koziol & Stevens, 2012), a dimensional hierarchical approach allows examining different types of networks or circuits the symptoms might map on (Kotov et al., 2021) and this would enable to avoid fictitious distinctions between nonclinical and clinical functioning.

Secondly, the shift from a categorical to a dimensional perspective has important implications for ADHD assessment and treatment. Although categorical thinking helps identify the most severe manifestations of attention related issues, clinicians who apply rigid cut-offs might miss relevant information in the case formulation of patients who suffer from milder disorders. Three severity levels (i.e., mild, moderate, and severe) were implemented for ADHD in the DSM-5 but modest changes have been produced in research and in clinical practice (McLennan, 2016). From public health purposes, addressing milder manifestations might have greater potential for population effects.

The role of executive functions in ADHD

Transitioning from a categorical to a dimensional model of ADHD implies to shift focus from distinct criteria defining specific impairments to the underlying processes involved, in particular executive functions (EFs). EFs are central in the clinical understanding of ADHD and attention related disorders. Relying on the distinction between cool and hot EFs (Rubia, 2011), as noted by Zelazo (2020, p. 441): "[although] the most common and consistent correlates of ADHD are measures of cool EF, there is growing appreciation of the role of hot EF difficulties such as high delay aversion, high temporal discounting, and *emotion dysregulation* (Petrovic & Castellanos, 2016)". The construct of EFs is particularly useful to understand and conceptualize ADHD, attention disorders, and their relationship with emotion dysregulation (Adler & Alperin, 2014; Soltanto, 2014). The term EFs refers to self-regulatory processes that organize, direct and manage other cognitive activities, emotional responses and behaviors (Gioia, Isquith & Guy, 2001; Stuss & Alexander, 2000). These operations control and support information processing that contributes to complex and goal-oriented behaviors. Such functions include the ability to plan and anticipate consequences of actions and the ability to direct attention, self-monitoring and self-consciousness to organize, control and change action schemes (Gazzaniga, Ivry & Mangun, 1998; PDM Task Force, 2018).

Specific deficits in these processes might affect the ability to regulate emotions, especially in people who suffer from attention related disorders and ADHD (Chan, Shum, Toulopoulou & Chen, 2008). Although based on different theoretical and methodological backgrounds, two models have included executive functions as a central feature of ADHD (Barkley, 2010; Brown, 2006). In this context, Barkley relied to a greater extent on theoretical models of cognitive functioning (e.g., Damasio, 1994; Fuster, 1997; Goldman-Rakic, 1995), whereas Brown developed his model based on clinical interviews with individuals who were diagnosed with ADHD and their families (Brown, 1996, 2001).

EFs are defined as neuropsychological processes that support human self-regulation, with the potential to change any resulting behaviors, altering the likelihood of their consequences (Barkley, 1997, 2001; Barkley & Murphy, 2006; Kanfer & Karoly, 1972). In this model, ADHD is seen primarily as an impairment of response inhibition. In the model behavioral inhibition refers to three interrelated processes: 1) inhibition of the initial response to an event; 2) interruption of an ongoing response; 3) protection of the delay between the decision to respond to an event and the self-directed responses from disruption by competing responses (interference control or resistance to distraction) (Bronowski, 1977). The response inhibition would be a precondition of self-regulation, and executive functions would refer to a set of self-directed behaviors that promote self-regulation. As such, ADHD and more in general attention disorders are associated with impairments in the prefrontal cortex and its connections to other brain regions, especially the striatum and cerebellum (Castellanos et al., 1994; Iversen & Dunnett, 1990). Along similar lines, Brown (2006) described attention related disorders as impairments of executive functions. The model is based on six cognitive functions clusters (i.e., activation, focus, effort, emotion, memory, and action) which could be impaired in individuals with ADHD. Each cluster includes functions that work through interactive automatic processes, that allow for the execution of everyday activities (Brown, 2001, 2005).

Emotion dysregulation and ADHD

Over the last decades, empirical evidence has supported the role of self-regulation as an important dimension for psychological assessment of attention related disorders and ADHD (Barkley, 1997, 2011, 2015). In this context, self-regulation is considered as the ability to develop and complete future plans, to interact with other people, to control impulses and ultimately allow people living in the society (Doerr & Baumeister, 2011). A construct which is deeply intertwined with self-regulation is emotional regulation, as posited by models emphasizing the integration of such processes across the lifespan (Diamond & Aspinwall, 2003; Koole, 2010). As described above, difficulties in emotion regulation have been identified as a core feature of attention related disorders and expression of underlying executive functions deficit (Barkley & Murphy, 2006; Barkley & Fischer, 2010).

Emotion regulation plays an important role in everyday activities. When emotions are efficiently regulated, they support cognitive abilities (such as memory and reasoning), behavioral responses, and interpersonal interactions (e.g., Hofmann, 2014; Seibert, Bauer, May & Fincham, 2017). When this process does not take place successfully, a series of maladaptive outcomes are observed, ranging from social difficulties (Eisenberg, Hofer & Vaughan, 2007; Shaver & Mikulincer, 2007; Wranik, Feldman Barrett & Salovey, 2007), to psychopathological disorders (Mullin & Hinshaw, 2007), and physical illness (Sapolsky, 2007).

Gratz and Roemer (2004) reviewed the literature concerning emotion regulation and proposed an integrative conceptualization of the construct as involving: a) the awareness, understanding and acceptance of emotions; b) the ability to control impulsive behaviors and behave in accordance with desired goals when experiencing negative emotions; and c) the capacity to use situationally appropriate regulation strategies flexibly to modulate emotional responses in order to meet individual goals and situational demands. Difficulties in emotion regulation are indicated by the absence or the dysfunction of one or all of such abilities (Giromini, Velotti, De Campora, Bonalume & Zavattini, 2012; Gratz & Roemer, 2004). Within a process model of emotion regulation, Gross (1998, 1999, 2007) suggests a sequence of processes involved in generating emotions in which each process is a possible regulation strategy. Emotion dysregulation can therefore happen on different levels of this process, for example in attentional deployment.

A potential relevant indicator of emotion regulation is alexithymia, intended as a specific form of emotional dysregulation, describing an affective regulation disorder with impairments in the cognitive-experiential domain of the emotional response systems and interpersonal regulation of emotions (Taylor, Bagby & Parker, 1997). Compared to other forms of emotion dysregulation, alexithymia tends to be transversal across the lifespan especially in its contribution to hyperactivity and impulsivity symptoms (Donfrancesco et al., 2013). Importantly, McCloskey and Perkins (2013) included self-awareness and awareness of others, which are closely related to the capacities to acknowledging one's own emotions as well as observing them in other individuals, as "potential indicators of executive functions difficulties" (p. 126).

Such theoretical background regarding emotion regulational processes is consistent with the explicatory models adopted in the present work in regards to attention related disorders, which are in turn associated with few controversies in its description. In particular, traditional definitions of ADHD generally focus on its three clinical components (inattention, impulsivity, and hyperactivity) and behavioral correlates such as the diminished ability to sustain attention or persist on tasks, difficulties to inhibit responses and delay gratification, excessive or inappropriate motor activity, and verbal productivity. However, influential works have underlined how the psychological functioning of individuals with ADHD might be described taking into account the role of maladaptive emotion regulation processes (Barkley, 2015; Brown, 2005). Along similar lines, significant overlaps between psychological functions involved in the Modal Model of Emotions (Barret, Oschner & Gross, 2007) and the most established descriptions of ADHD might be found. For instance, impulsivity might be related to difficulties in situation selection, whereas impairment in effectively deploying attentional resources may be associated with difficulties with emotional reactivity and expression.

Despite a large body of literature suggests the importance of emotion regulation in defining ADHD (e.g., Pelham, 1982; Strauss & Lehitnen, 1947; Woods, 1986), the construct does not currently appear neither among the diagnostic criteria in the DSM-5 (APA, 2013) nor in the ICD-11 (World Health Organization, 2019). Besides historical reasons, methodological issues might explain the exclusion of emotional regulation from the description of diagnostic criteria for ADHD. Firstly, with some notable exceptions,

such as aggressivity (Whalen & Henker, 1985) or frustration tolerance (Mischel, Shoda & Rodriguez, 1989), emotion dysregulation is a construct encompassing both intrinsic and extrinsic processes (Gratz & Roemer, 2004; Thompson, 1994) and is therefore less prone to be studied through performance based methods whereas more observable symptoms such as attentive deficits and behavioral problems tend to be easier to measure and quantify. Secondly, it is possible that research on attention disorders, as well as the assessment measures developed through the years, do not include emotion regulation within the conceptualization of the disorder because they rely on the DSM description of ADHD; this has been limited to impairments in the cognitive (i.e., intattention) or behavioral (i.e., hyperactivity, impulsivity) areas since the DSM-II (APA, 1968; Douglas, 1972). Difficulties in the emotional domain were left out until the fourth edition of the manual, whichintroduced low frustration tolerance, irritability, and humor lability, as associated features. Symptoms of emotional dysregulation per se belonged in fact to the Oppositional Defiant Disorder (ODD) that, standing to the DSM, is closely associated to ADHD (Barkley, 2010).

Notwhisstanding this absence in the official nosography, evidence from neuropsychological studies supported the key role of emotion dysregulation in ADHD attention disorders (Shaw, Stringaris, Nigg & Leibenluft, 2014). Empirical studies focused on specific neuroanatomical patterns associated with attention disorder and found evidence for the involvement of the lateral prefrontal cortex (LPFC) and anterior cingulate conrtex (ACC; Bush, Valera & Seidman, 2005) in connection with the medial prefrontal cortex and limbic system. In particular, Ochsner and Gross (2007) found that hyperactive, disattentive and impulsive behavior and emotional inhibition on the one hand, and cognitive and executive control of emotions on the other, are based on the same neural connections. Observational studies on children who were diagnosed with ADHD reported specific differences in many psychological domains, such as expression of negative emotions (Rosenbaum & Baker, 1984), interactions with peers (Johnston & Mash, 2001), and frustration tolerance (Milich & Okazaki, 1991) between clinical and control groups.

Studies on emotion regulation and its interaction with ADHD and attention disorders are important not only in order to expand our knowledge of this clinical condition but also for their implications on treatment and interventions across different ages. For instance, emotional dysregulation of children with ADHD has been found as a risk factor for non-cooperative activities and negative interactions with peers (Whalen & Henker, 1992), such as difficulties in following the rules, tearfulness, and inattention (Mrug, Hoza, Pelham, Gnagy & Greiner, 2007). Similalrly, difficulties in emotion regulation such as emotional impulsiveness are considered major factors in impairment in daily life of hyperactive children as adults (Barkley & Fischer, 2010).

The present study

In the present study we explored the relationships between multiple components of emotional dysregulation, alexithymia (Bagby et al., 1994a, 1994b; Taylor et al., 1997) and their effects on ADHD symptoms in nonclinical late adolescents. Specifically, we expected that emotion regulation skills will be significant predictors of attention abilities after controlling for the role of executive functions.

METHOD

Participants

135 senior students (89 men; corresponding to 66% of the sample) from two different high schools located in the North of Italy were involved in the study. The mean age of the sample was 18.6 years (*SD* = .71; age range: 18.6-19 years; unlike the United States, Italian high schools are five years long, and the usual senior students' age ranges from 18 to 19).

Most of the particpants identified themselves as Italian (*n* = 132, 97.8%), whereas a small fraction had a foreign nationality (*n* = 3, 2.2%). Participants were included in the study only if they were not receiving, nor had received in the past, medical treatment for psychiatric conditions.

Measures

A brief description of each instrument contained in the research battery of this study is provided below, and internal consistency values for each scale used in the analyses is reported in Table 1.

– The *Brown ADD* scales (Brown, 2001; Del Corno, Lang & Schadee, 2007) is a 40-item self-report questionnaire that

Table 1 – Descriptive statistics for target variables

Variable	Min	Max	*Mean*	*SD*	Skewness	Kurtosis	Cronbach's alpha
ADD Total	9.0	93.00	46.5	18.66	.37	−.31	.921
ADD Cluster 1	0	23.00	11.22	4.82	.17	−.50	.728
ADD Cluster 2	0	24.00	12.60	4.98	.23	−.16	.781
ADD Cluster 3	0	24.00	9.76	5.26	.50	−.29	.785
ADD Cluster 4	0	18.00	6.86	4.26	.47	−.62	.743
ADD Cluster 5	0	15.00	6.12	3.21	.34	−.46	.640
BRIEF-A MI	43.00	103.00	68.24	11.22	.51	.41	.890
BRIEF-A BRI	30.00	75.00	50.92	7.93	.36	.08	.829
TAS Total	26.00	79.00	49.80	12.10	.23	−.76	.826
DERS Total	43.00	141.00	85.40	21.40	.36	−.48	.843

Legenda. ADD = *Brown Attention-Deficit Disorder Scale*; ADD Cluster 1 = Organizing, prioritizing and activating to work; ADD Cluster 2 = Focusing, sustaining and shifting attention to tasks; ADD Cluster 3 = Regulating alertness, sustaining effort and processing speed; ADD Cluster 4 = Managing frustration and modulating emotions; ADD Cluster 5 = Utilizing working memory and accessing recall; BRIEF-A MI = BRIEF-A Metacognition Index; BRIEF-A BRI = BRIEF-A Behavioral Regulation Index; TAS Total = *Toronto Alexithymia Scale* total score; DERS Total = *Difficulties in Emotion Regulation Scale* total score.

measures a wide set of attention-related symptoms and allows for the assessment of ADHD with specific attention to the predominantly inattentive presentation. The Brown ADD scales require respondents to evaluate how often certain feelings and behaviors occur on a four-point Likert scale. Composite scores represent five core domains related to attention disorders (i.e., clusters): Organizing, prioritizing and activating to work; Focusing, sustaining and shifting attention to tasks; Regulating alertness, sustaining effort and processing speed; Managing frustration and modulating emotions; Utilizing working memory and accessing recall. The test shows excellent internal consistency and test-retest reliability.

– The *BRIEF-A* (Gritti et al., 2017; Roth, Isquith & Gioia, 2005) is a 75-item self-report questionnaire that measures executive functions and self-regulation processes. Respondents are required to rate how often certain conditions have been occurred in the previous 30 days on a three-point Likert scale. Nine scales allow for the description of multiple components of executive functioning: Inhibit; Plan/Organize; Shift; Initiate; Task monitor; Self-monitor; Emotional control; Working memory; Organization of materials. The test allows for the calculation of 5 clusters organizing the various components of attention: Cluster 1 (Organizing, prioritizing and activating to work), Cluster 2 (Focusing,

sustaining and shifting attention to tasks), Cluster 3 (Regulating alertness, sustaining effort and processing speed), Cluster 4 (Managing frustration and modulating emotions), and Cluster 5 (Utilizing working memory and accessing recall). The subscales can be combined into three composite scores, i.e., the Behavioral Regulation Index (BRI), consisting of Inhibit, Shift, Emotional control, and Self-monitor scales, and the Metacognition Index (MI), consisting of Initiate, Working memory, Plan/Organize, Task monitor, Organization of materials scales, as well as the Global Executive Composite (GEC), which is the overall score for the evaluation of executive functions. Three validity scales are available, i.e., Negativity, Inconsistency and Infrequency. Higher scores from the correspond to greater executive dysfunctions. The test has from good to excellent internal consistency, and excellent temporal stability over four-week time.

– The *DERS* (Giromini et al., 2012; Gratz & Roemer, 2004) is a 36-item measure of emotional dysregulation; the items are rated on a five-point Likert scale. The instrument provides scores for six components of emotion regulation: non-acceptance of emotion responses and reactions (Nonacceptance); lack of emotional clarity (Clarity); impulse control difficulties (Impulse); lack of emotional awareness (Awareness); limited access to emotional regulation strategies (Strategies); difficulties in undertaking goal-oriented behaviors (Goals). Higher scores indicate impairments in emotion regulation. The test has an excellent internal consistency and a good test-retest stability both in clinical and non-clinical populations (Fox, Axelrod, Paliwal, Sleeper & Sinha, 2007; Gratz, Tull, Baruch, Bornovalova & Lejuez, 2008).
– The TAS-20 (Bagby et al., 1994a, 1994b; Bressi et al., 1996) is a measure of alexithymia which requires respondents to rate how well they are represented by the items on a five-point Likert scale. The items are combined in a total score and three subscales: Difficulties identifying feelings; Difficulties describing feelings; Externally oriented thinking. The test has good internal consistency and test-retest stability both in non-clinical and clinical samples.

In synthesis, the Brown ADD Scales, the BRIEF-A, the DERS, and the TAS-20 were used to measure relevant aspects of ADHD functioning and emotional regulation. The five clusters and the total scale score from the Brown ADD scales were used to measure attention-related difficulties. BRIEF-A Metacognition Index (MI) and Behavioral Regulation Index (BRI) were used as indicators of executive functions, whereas the DERS and TAS-20 scales were utilized to evaluate components of emotional regulation. The construct of alexithymia was included as an indicator of emotional dysregulation according to the evidence that patients who suffer from this condition tend to act impulsively rather than mentalize strong feelings and emotions (La Ferlita, Bonadies, Solano, De Gennaro & Gonini, 2007).

Ethical statements

The board of education of each school where data have been collected approved the participation to the study. Only participants older than 18 years have been recruited and each of them provided written informed consent before entering to the research by filling-up the appropriate document in paper format administered individually by the examiner. The study has been performed in accordance with the ethical standards described in the 1964 Declaration of Helsinki.

Procedures and data analysis

The battery of questionnaires was administered in each class in group, lasted about 35 minutes, and it was supervised by researchers and teachers. Data from three participants were excluded from the analyses because their scores on BRIEF-A were invalid (i.e., high values in Negativity, Infrequency, and Inconsistency scales, and/or more than 14 omitted responses). Therefore, analyses were performed on 132 cases.

After the distributions of the target variables were examined for potential departures from normality and level of internal consistency (i.e., Cronbach's alpha), main analyses started. Firstly, the correlations between executive functions and emotional dysregulation were inspected, considering the BRIEF-A MI and BRI, the DERS and the TAS-20 Total scores, respectively. The relationships among target variables were then studied through a series of multiple regression analyses, to examine the unique contribution of the key components of executive functions, the ability to identify and describe emotions, and emotion regulation on attention-related dysfunctional symptoms. In order to identify the role of emotional dysregulation more precisely in ADHD and behavior regulation after controlling for the influence of the

Metacognition Index, widely thought as the best indicator of the multiple components of executive functions available in the measures used in this study, multiple regression with stepwise method was used. Metacognition Index was entered in the first step and the other predictors were entered simultaneously in the second step. Analyses were performed through the software Statistical Package for Social Science (SPSS).

RESULTS

The ten target variables met the assumptions of normality (see Table 1) and, with one exception (i.e., ADD Cluster 5), all scales reached good or excellent levels of internal reliability. Results of the correlations between executive functions and emotional dysregulation, considering the BRIEF-A MI and BRIEF-A BRI, the DERS and the TAS-20 Total scores, showed positive statistically significant correlations ranging from moderate to high and statistically significant ($p \leq .01$, two tailed) (see Table 2; although being a particularly stringent procedure in the context of an exploratory study, we also calculated Bonferroni correction to the correlations tested following reviewer's suggestion. No significant pattern emerged, but it is noteworthy that 8 out of 14 correlations remained significant after applying the correction. Namely, these were the correlations between all ADD clusters and TAS total score and those between ADD clusters 2, 3, 4 and DERS total).

Multiple regression analyses were conducted after checking that multicollinearity indexes for regression models were appropriate, excluding the presence of problematic correlations between the predictors. Results from multiple regression analyses with stepwise method, with Metacognition Index entered in the first step and the other predictors entered simultaneously in the second step are showed in Table 3.

Table 2 – Correlations of ADHD and executive functions with emotion dysregulation

	TAS Total	DERS Total
BRIEF-A BRI	.44**	.62**
BRIEF-A MI	.43**	.44**
ADD Cluster 1	.52**	.52**
ADD Cluster 2	.41**	.48**
ADD Cluster 3	.38**	.40**
ADD Cluster 4	.59**	.67**
ADD Cluster 5	.38**	.46**

Legenda. BRIEF-A MI = BRIEF-A Metacognition Index; BRIEF-A BRI = BRIEF-A Behavioral Regulation Index; ADD = *Brown Attention-Deficit Disorder Scale*; ADD Cluster 1 = Organizing, prioritizing and activating to work; ADD Cluster 2 = Focusing, sustaining and shifting attention to tasks; ADD Cluster 3 = Regulating alertness, sustaining effort and processing speed; ADD Cluster 4 = Managing frustration and modulating emotions; ADD Cluster 5 = Utilizing working memory and accessing recall; TAS Total = *Toronto Alexithymia Scale* total score; DERS Total = *Difficulties in Emotion Regulation* Scale total score.
** $p \leq .01$

Table 3 – Linear regressions predicting Brown ADD clusters and total score from BRIEF-A MI (Step 1), and multiple regressions predicting Brown ADD clusters and total score adding BRIEF-A BRI, DERS Total, TAS-20 Total to the model (Step 2)

	Brown ADD scales											
	Cluster 1		*Cluster 2*		*Cluster 3*		*Cluster 4*		*Cluster 5*		*ADD Total*	
Predictors	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β
Step 1	.53***		.45***		.53***		.13***		.32***		.56***	
BRIEF-A MI		.73***		.67***		.72***		.36***		.56***		.75***
Step 2	.08***		.05*		.01		.44***		.06*		.12***	
BRIEF-A MI		.57***		.56***		.67***		−.01		.44***		.56***
BRIEF-A BRI		.13		.02		.07		.36***		−.03		.14*
DERS Total		.09		.21*		.04		.29**		.26*		.20**
TAS-20 Total		.15*		.02		.04		.25**		.04		.12
Total R^2	.61***		.49***		.54***		.57***		.37***		.68***	

Legenda. BRIEF-A MI = BRIEF-A Metacognition Index; BRIEF-A BRI = BRIEF-A Behavioral Regulation Index; ADD = *Brown Attention-Deficit Disorder Scale*; ADD Cluster 1 = Organizing, prioritizing and activating to work; ADD Cluster 2 = Focusing, sustaining and shifting attention to tasks; ADD Cluster 3 = Regulating alertness, sustaining effort and processing speed; ADD Cluster 4 = Managing frustration and modulating emotions; ADD Cluster 5 = Utilizing working memory and accessing recall; TAS Total = *Toronto Alexithymia Scale* total score; DERS Total = *Difficulties in Emotion Regulation Scale* total score.
* $p \leq .05$; ** $p \leq .01$; *** $p \leq .001$

Importantly, results indicate that, with the exception of ADD Cluster 3 (Regulating alertness, sustaining effort and processing speed) in which Metacognition Index was the only significant predictor of the ADD variance, the addition of emotional dysregulation index and behavioral regulation to the equation, after controlling for Metacognition Index, systematically increased the portion of predicted variance in ADHD.

A more thorough analysis of the combined model shows specific patterns of associations between the measures of emotional dysregulation and behavioral regulation and the ADHD clusters. In the case of ADD Cluster 1 (Organizing, prioritizing and activating to work), the best predictor when controlling for Metacognition resulted to be the level of alexithymia reported by the participant ($r = .15$, $p \leq .05$). Dysregulation as measured by the DERS was in turn the best predictor after Metacognition Index for ADD Cluster 2 (Focusing, sustaining and shifting attention to tasks; $r = .21$, $p \leq .05$) and ADD Cluster 5 (Utilizing working memory and accessing recall; $r = .26$, $p \leq .05$). As noted above, ADD Cluster 4 (Managing frustration and modulating emotions) was the area in which the influence of emotion and behavioral dysregulation was stronger, with alexithymia, emotional and behavioral dysregulation, measured by the DERS, TAS-

20 and BRIEF-A respectively, being the sole predictors of executive functioning impairment (r = .29 and .25, $p \leq .001$).

Finally, the scores of the five ADD clusters considered as a whole (ADD Total) were predicted by a combination of factors in which, after controlling for the effect of Metacognition Index, emotion dysregulation as measured by the DERS (r = .20, $p \leq .01$) preceded behavioral regulation measured by the BRIEF in terms of predictive power (r = .14, $p \leq .05$).

DISCUSSION

The present study aimed at evaluating the role of emotional dysregulation in late adolescents, with the main hypothesis being that capacities to regulate emotions and affects, along with the more general metacognitive abilities, would be a significant predictor of subclinical symptoms of attention-related disorders. We sought to examine in a late adolescents' nonclinical sample if difficulties in managing emotions and affects would have contributed to a higher presence of difficulties similar to those generally reported by individuals with ADD (e.g., struggles being attentive or utilizing working memory efficiently).

Firstly, our results confirmed the expected finding in the light of the reviewed literature: problems in metacognition proved to be the best predictors of lower scores in the scales from Brown's ADD questionnaire evaluating the presence of attention deficits. This confirms the close association between executive functioning, in this case specifically measured in its components of planning and organization rather than in its more behavioral dimension, and attention disorders. Such connection could be explained by the neuroanatomical proximity between the prefrontal cortex and associated areas which are considered the bases of executive functions and the cerebral regions normally observed as dysfunctional in ADHD (Murphy, Barkley & Bush, 2001; Roth & Saykin, 2004; Woods, Lovejoy & Ball, 2002).

Beyond this anticipated finding, significant relations were found between emotion regulation and deficits normally associated to ADHD and ADD. The central hypothesis arguing in favor of the importance of emotional dysregulation in the definition of ADHD and ADD was substantially confirmed. In fact, with the exception of ADD Cluster 3 (Regulating alertness, sustaining effort and processing speed), whose variance was predicted solely by the Metacognition Index, adding emotion and behavioral dysregulation into the equation, after controlling for the Metacognition Index, systematically increased the portion of predicted variance of the ADD overall score as well as the single clusters for which specific patterns emerged. Therefore, the expected link between the adult's capacities to regulate and express emotions, measured by the DERS and TAS-20 scales, and the presence of cognitive difficulties that are frequently shown by individuals with ADD as the predominant difficulty was confirmed.

In terms of the relationship between dimensions of emotion regulation and the different clusters of ADD, results showed several significant relationships. The role of emotion regulation in defining the various ADHD (predominantly inattentive subtype) components might be interpreted in relation to the models that consider the abilities to self-regulate and managing affects as a key component of the executive functions' domain (Barkley, 2015; Brown, 2005).

A central point to consider in understanding the present results is that controlling for the effect of Metacognition Index allowed to more closely study the relations between emotion regulation and attention problems without the influence of the primary factor involved in the psychological and cognitive impairment reported by individuals with problems in the areas generally affected by ADHD. The impact of metacognition difficulties on the different clusters was exclusive in the domains of regulation of alert, ability to sustain effort and processing speed (ADD Cluster 3) but not in the remaining ADD clusters. As discussed, the important impact of Metacognition difficulties in ADD clusters was fairly expected considering that Metacognition Index reflects abilities such as initiating activities, sustaining working memory, organizing strategies, and generating problem solving ideas (Roth et al., 2005). However, beyond this finding, difficulties in emotion regulation and capacities to identify and recognize one's own affective states resulted to be significantly connected to the presence of impairment in the cognitive functions relevant to negative outcomes, such as ADD symptoms, independently from the level of metacognitive functioning.

Both Barkley (2015) and Brown (2005) pointed out how impairment in executive functions would be particularly relevant in the clinical functioning of adult individuals with attention problems and ADHD, also to a greater extent than what is observed for younger individuals. Considering emotional regulation intimately connected to executive functions, the influence of emotion dysregulation and

alexithymia in the domains of activating and organizing to work, as well as using working memory and sustaining attention during tasks (ADD Cluster 1, 2 and 5) that have been observed in the present sample might be interpreted as instances of the interference of emotional stimulations on the higher colder cognitive functioning of the individual. Moreover, fluctuations in such cognitive abilities might have important repercussions on the level of efficacy and motivation with which people will face everyday tasks and possibly could ultimately affect their work achievement and success.

Finally, even though less central to the overall aim of the present study, the analysis focused on the ADD cluster relative to the abilities to manage frustration and modulate emotions (Cluster 4) revealed how these processes are mainly connected to the individual's capacity of maintaining an appropriate control over their behavior and emotional responses. In other words, difficulties in inhibiting impulsive thoughts and actions, shifting from one problem-solving set to the other, modulating affective responses and monitoring one's own behavior, were associated to greater emotional interferences in thought processes and execution of tasks. Although interesting, this association might be mainly due to some overlap between the measures used for studying behavioral regulation, emotion regulation and emotional interferences as part of the ADD scores and should be therefore confirmed in other settings.

The close connection between emotion dysregulation and the defining components of ADHD goes in the direction of the conceptualizations identifying emotion dysregulation as a central dimension of attention-related impairments. Consequently, emotional dysregulation patterns might associate with and have cumulative effects in those of hyperactivity and impulsivity. Along these lines, the role of emotion and affect regulation might represent a useful tool in the treatment of individuals with attention problems and a crucial point of intervention to improve their psychological well-being. In this regard, the results of the present study suggest that from a primary prevention standpoint for ADHD, and especially ADD, incorporating specific interventions aimed at fostering greater emotional awareness and regulation might be valuable. As such, individuals experiencing attention deficits, but also difficulties in organizing for everyday tasks, managing frustration and emotions as well as using their working memory efficiently, might benefit from helping them limiting the interference of emotion dysregulation on their cognitive functioning.

The relations between emotion regulation and attention-related impairments might also contribute to explain developmental mechanisms observed in the trajectory from childhood to adulthood in individuals with ADHD and attention related difficulties (Bunford et al., 2018). Evolving from childhood to adolescence and then adulthood, hyperactivity tends to decrease, whereas cognitive difficulties, and inattention, in particular remain more stable, although with different intensity and frequency according to the mutated developmental tasks and requests of the environment (Weiss & Hechtman, 1993). The consequences in adulthood might result in work-related and interpersonal problems, which in turn lead to repeated job changes, conflicts, and dissatisfaction. Consequently, self-regulation and more specifically the ability to tolerate feelings of frustration for failures might play as a risk factor for the adaptation to one's environment and quality of life (Adler & Silverstein, 2018; Barkley, Murphy & Fischer, 2008).

On a more speculative side, evidence of the involvement of emotion regulation abilities in ADHD, although observed in this case in an adult sample, might also contribute to throw light on the different etiopathogenetic and maintaining factors of the disorder. Considering the relational nature of the phenomenon of emotion dysregulation, it is possible to envision the role played by individual differences in emotion regulation during early childhood in the development of the relationship with the caregiver and, in turn, in the child's future personality. If constitutional individual differences in temperament and relatedness can contribute to shape specific responses of the caregiver (Thomas, Chess & Korn, 1982), early impairment in emotion regulation and their impact on the child-caregiver interaction might contribute to the environmental factors that bear on the concrete and daily managing of ADHD (Henker & Whalen, 1999; Seymour, Chronis-Tuscano, Iwamoto, Kurdziel & MacPherson, 2014). In a circular pattern of reciprocal influence, child-caregiver interactions might themselves affect, along with the innate abilities of self-regulation and sensory process, the child's relational development (Greenspan, 1997).

The findings of the present study contribute to throw light on the interactions between the construct of emotion regulation and executive functions, supporting views that identify emotional dysregulation as tightly connected to other problems which are generally reported by individuals with ADHD such as inattention and impulsivity.

CONCLUSIONS

In conclusion, the findings of the present work represent a contribution that goes in the direction of enriching our understanding of the psychological functioning of individuals with attention-related disorders as well as of those with problems in the executive functions domain when they face the challenges of adult life. In line with this, extending our knowledge about how difficulties in the understanding and management of emotions interact with impairments in the domain of executive functioning might be crucial for better understanding and treating individuals who show clinical problems related to ADHD during the life-span (Barkley & Fischer, 2010).

Furthermore, given that most of the empirical research on the inattentive subtype of ADHD is drawn from research on ADHD (Adams, Milich & Fillmore, 2010), tailoring our analysis to attention deficit specifically contribute to the literature on this less studies but equally relevant clinical presentation.

Considering that difficulties in experiencing and dealing with emotions are not included in the descriptive criteria for ADHD in the major diagnostic systems, this investigation contributes to a more clinically accurate understanding of the disorder. A more thorough definition and understanding of the different psychological dysfunctions implied in a disorder might also be useful in planning and tailoring therapeutic interventions for the target clinical populations.

Limitations and directions for future research

Along with the promising findings, the present study also retains a few limitations that might serve as a stimulus for future research. Most notable is the exclusive focus on self-report assessment of the variables object of analysis. Although less demanding and invasive for participants, relying only on self-reports might have somewhat limited the inferences and findings that might derive from the collected material. Considering the benefits of multimethod assessment (Meyer et al., 2001), future studies aimed at connecting the various aspects of ADHD and emotion dysregulation on young adults encompassing also other sources of data (e.g., performance measures and informant-reports) could be particularly useful to deepen the understanding of the relationships between these constructs. Moreover, relying on multiple sources of assessment might also circumvent potential psychometric shortcomings of a single method. In this study, for instance, although most of the scales used reached good to excellent levels of internal consistency, one scale (i.e., ADD Cluster 5) resulted to be in the acceptable range. Although this does not challenge the validity of the study findings, but it might have reduced the strength of the observed relationships.

Secondly, the present work is based on a correlational logic, and this therefore prevents us from drawing solid causal paths. Studying such constructs in experimental settings or with an emphasis on longitudinal trajectories would potentially allow to improve the generalizability of our findings. A promising avenue for future research would be to investigate the influence of the participants' age, for example replicating the analyses of this study across different age groups, on the relationships between the different variables. This would also help to understand if the significant relationships identified between emotional dysregulation and aspects of hyperactivity and inattention is specific to the late adolescence period or can be generalized to older individuals.

Finally, the fact of focusing on a non-clinical setting might have the benefit of expanding the description of the relationships between emotion regulation and variables connected to executive functioning to below the cut-off samples and allows for generalization to the general population. However, replicating the present study on clinical settings would be important to corroborate the results obtained and potentially provide further information.

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The Defense Style Questionnaire – 40: Urdu translation, validation, and its uses among parents of children with autism spectrum disorder

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ABSTRACT. Lo scopo del presente studio è stato quello di tradurre, validare e verificare l'uso rilevante dei meccanismi di difesa tra i genitori di bambini con disturbo dello spettro autistico. Sono stati reclutati: *N* = 60 genitori con uguale distribuzione per la validazione linguistica, *N* = 350 genitori per le proprietà psicometriche della scala *Defense Style Questionnaire – 40* e per testare il ruolo dei meccanismi di difesa, *N* = 600 genitori con uguale distribuzione da diversi centri per l'autismo del Punjab, Pakistan. I risultati dell'analisi fattoriale di conferma hanno supportato una struttura a tre fattori con indici di adattamento al modello ragionevolmente buoni ($\chi^{2/df}$ = 2.95, GFI = .92; CFI = .93 e RMSEA = .05). Il significato degli item e il loro contenuto nella versione Urdu del DSQ–40 erano simili alla versione originale inglese. Le correlazioni tra gli item (*r* = .99; *p*<.01) e l'alfa di Cronbach (.89) della versione tradotta del DSQ–40 hanno dimostrato un'affidabilità promettente. In conclusione la versione tradotta in Urdu del DSQ–40 è una misura valida che può essere usata con i genitori che hanno un figlio con disturbo dello spettro autistico o altre disabilità.

SUMMARY. The aim of the present study was to translate, validate, and see the relevant use of defense mechanisms among parents of children with autism spectrum disorder. In total sixty (N = 60) parents with equal distribution were recruited for the cross language validation, three hundred fifty (N = 350) parents were recruited for psychometric properties of the Defense Style Questionnaire – 40 scale and for testing the role of defense mechanism six hundred (N = 600) parents with equal distribution (300 fathers and 300 mothers) were recruited from different autism centers of Punjab, Pakistan. The result of confirmatory factor analysis supported three factor structure with reasonably good model fit indices $\chi^{2/df}$ *= 2.95, GFI = .92; CFI = .93, and RMSEA = .05). The meaning of items and their content in Urdu version of DSQ–40 was similar to the original English version. The inter item correlations (r = .99; p<.01) and Cronbach's alpha (.89) of translated version of DSQ–40 had promising reliability. Further, most parents use neurotic defense mechanisms to overcome the reality of having a child with neurodevelopmental condition. We concluded that the Urdu translated version of Defense Style Questionnaire – 40 was a valid and reliable measure and we may continue to use it with parents having a child with autism spectrum disorder or other disabilities.*

Keywords: *Defense Style Questionnaire – 40, Urdu translation, Cross language validation, Validity, Reliability*

INTRODUCTION

In clinical psychology and psychotherapy, defense mechanism is an important concept for the identification and understanding of human behavior. It is believed that defense mechanism protects us from excessive anxiety and tension (Cramer, 2006; Valliant, 1994). Sigmund Freud theorized defense mechanism in 1894 and modified the concept several times ago over a period of 40 years (Freud, 1894, 1915, 1926). Freud endorsed for theorizing the defenses of projection, denial, repression, fantasy, displacement, dissociation, humor, suppression, sublimation, reaction formation and intellectualization (Valliant, 1992). In DSM–5, the concept of defense mechanism has been excluded due to the lack of scientific evidence to support it. But still researches have been undertaken on defense mechanism as on one hand, it helps in coping, but on the other hand, it may create negative effect. In the early 80's a movement began, to add defenses in a new axis in DSM–3–R (Karasu & Skodol, 1980) to provide the best definition of construct to operationalize the mechanisms. But, due to different opinions, defenses were exile to an appended glossary in DSM–3–R (American Psychiatric Association, 1987).

In 1986, an advisory committee on defense mechanisms was formed to develop a sixth axis completely for assessing defense mechanism, where the function of defense assessment was shown to have incremental validity above the DSM's global functioning scale to be transtheoretical and valid (Skodol & Perry, 1993). In such a positive decision, the committee was setup to reserve the axis for ranking a defense style, where client's characteristics of dealing with stress and conflicts were broadly described. Further, it was also suggested that axis would use maximum seven individual defenses to record which were reliable or less reliable to be clinically used (Skodol & Perry, 1993). In 1994, defensive functioning scale was included in DSM–4 as an axis which contained 27 specific defenses ranking form one of seven levels. Many studies confirmed the incremental validity in relation to the other axes and also check the reliability and their clinical utility, where the results demonstrated the importance of defense mechanism in mental health practice (Perry & Hoglend, 1998; Perry et al., 1998).

The *Defense Style Questionnaire* (*DSQ*) is one of the most esteemed scale, originally constructed by Bond and his colleagues (Bond, Gardner, Christian & Sigal, 1983). It was 88 items scale with 25 defenses having low reliability and 4 factor style scale. Later, the DSQ underwent through many revisions for increasing their reliability and validity. Many researchers failed to cite the proper version of the scale for instance, how many defenses and numbers of items were included etc. Andrews, Singh and Bond (1993) finalized 40 items and 20 defenses (2 items per defense mechanism) having 3 factor structure: Mature style (Sublimation, Anticipation, Humor and Suppression), Neurotic style (Undoing, Pseudo–altruism, Idealization and Reaction–formation) and the Immature style (Projection, Passive–aggression, Acting–out, Isolation, Devaluation, Autistic fantasy, Denial, Displacement, Dissociation, Splitting, Rationalization and Somatization). The 40 item version of the *Defense Style Questionnaire* has been declared to be stronger and more accurate version than the previous DSQ factor solutions (Thygesen, Drapeau, Trijsburg, Lecours & de Roten, 2008).

From the time, when *Defense Style Questionnaire – 40* was developed, it has been used in various settings to find out the importance and how it works in dealing with daily conflicts. Many researches claim that this tool is very helpful in clinical assessment. In various settings, mixed findings showed different factor structure solution, ranging from 3 to 6 factors and internal consistency varied from .51 to .81 (Andrews et al., 1993; Lopez & Gormley, 2002; Ruuttu et al., 2006; Watson & Sinha, 1998). Various versions of *Defense Style Questionnaire* has been translated and validated in various languages. Crasovan and Maricutoiu (2012) translated the *Defense Style Questionnaire – 60* in Roman language and administered on a sample of 1200 individuals, where 249 were students, 203 medical students, 30 were hotel employees and 469 adults from various occupations. The *Defense Style Questionnaire – 88* was translated in Italian (sample = 582), French (220 patients) and Greek (2308 patients) language. They administered the scale on different populations belonged to different occupations such as students, teachers, civil servants, outdoor patients, indoor patients and psychiatric patients (Bonsack, Despland & Spagnoli, 1998; Hypantis, 2010; Martini, Roma, Sarti, Lingiardi & Bond, 2004). Further, DSQ–40 was translated in Brazilian and Arabic (28 patients diagnosed with major depressive disorder) language (Blaya et al., 2004; Soliman, 1997). The scale has shown promising validity and reliability in different languages and cultures.

Defense Style Questionnaire – 40 was not available in Urdu. So in order to use DSQ–40 in Pakistan, it was mandatory to translate it into Urdu language, so that it is comprehensible and could be used for research purpose. In

Pakistan, autism spectrum disorder is growing rapidly and affecting approximately 400.000 children (SAAAC, 2022). In this study, we selected only parents of children with autism spectrum disorder because there been an increase in demand for psychological support from parents of children with ASD other than other developmental disabilities in Pakistan. As other developmental disabilities are already treated and their caregivers are getting proper treatment in Pakistan (Imran & Azeem, 2014). In Pakistan parents reported that there is lack of awareness among health professionals about ASD and parents developed non–acceptance behavior toward children and later when they accepted their child they started using different defense mechanism to cope the embarrassing situation i.e., denial, projection etc. (Hassan, 2021). So, in this study we specifically choose parents of children with ASD and we specified the age range to maintain the homogeneity of the sample. Further, the psychometric investigations of *Defense Style Questionnaire – 40* have never been established for parents having a child with autism spectrum disorder (ASD). So this study aimed to translate DSQ–40 in Urdu and establish its psychometric properties and see the relevance uses on the parents having a child with ASD.

Autism spectrum disorder is a lifetime neurodevelopmental condition; it affects not only the child but also the members of the family and can bring a number of changes in their lives. Autism is a complex neuro–developmental condition, usually identified in early childhood. It affects a child's communication, socialization, cognition, behavioral difficulties, and social interaction. It was first identified in 1943 by a child psychiatrist, Leo Kanner. In early years, autism was mostly diagnosed as childhood schizophrenia'(Tian et al., 2022; Tidmarsh & Volkmar, 2003).

The *Diagnostic and Statistical Manual of Mental Disorders – 5* (*DSM–5*) has changed the diagnosis of a multi–categorical model of a single diagnostic category of autism spectrum disorder (APA, 2013). Now it comes under neurodevelopmental disorder with core deficits in two domains: social interactions and social communication as well as restricted repetitive patterns of behavior, interests, or activities (APA, 2013). DSM–5 removed other categories of autistic disorder and replaced them with autism spectrum disorder (APA, 2013). Furthermore, DSM–5 has also included sensory disturbances such as hyper or hyposensitivity to sensory stimuli (e.g., excessive smelling or touching and visual fascination with objects) in its criteria (APA, 2013). Different levels of severity, based on the support needed, have been mentioned in the new classification. In addition to ASD, a new category of social communication disorder has been created in DSM–5 (APA, 2013). In social communication disorder, there are persistent difficulties in the social use of verbal and nonverbal communication.

Therapists, physicians, and psychologists using different techniques (i.e., applied behavior analysis) to reduce the behavioral issues among children with ASD, but neglected to focus on parents. Professionals were not aware of the significance of stigma, which surrounded the parents of children with ASD (Weastell, 2017). Parents of children with ASD are discriminated against based on their child's abilities and behaviors that lead them to face different challenges such as parental stress. Autism spectrum disorder not only causes stress among parents but also has a delirium impact on social relations and marital relationships of the parents (Brobst et al., 2009; Gau et al., 2011; Higgins et al., 2005; Parker et al., 2011). Weastell (2017) reported in a review that the current situation and difficulties of parents in having a child with ASD contradicted with earlier theories of the 1940s and 1950s on autism etiology. Like, Freudian suggested that cold and unemotional parents such as mother, father, or legal caregiver were to blame for the generous love and care.

Chaturvedi (2014) reported, when families get to know about the neurodevelopmental condition of a child, their reaction are ranging from sadness to anger. Diagnosing of autism made families into an unhealthy pattern of denial. Parents reported that the word autism was no more than a label but created fear and feeling of failure. Most of the parents also reported that they neglected their child due to the fear that they could not handle them and misunderstanding led to denial.

Further, literature also evident that parent use different defense mechanism as coping which play significant role in reducing the stress and stigma of parents of children with ASD (Lazarus & Folkman, 1999). However, there are very less evidences on using defense mechanisms as coping that may help protect and even encourage caregiver quality of life and increase the level of sense of coherence.

In order to meet the objectives, present study was completed in four phases. Phase I aimed to translate the instrument, Phase II aimed at cross validation, Phase III aimed to establish psychometric properties and run the confirmatory factor analysis to indorse the original factor structure for the translated version of DSQ–40 and Phase IV to find out the mostly used defense mechanism among parents of children with ASD.

METHOD AND PROCEDURE

Transparency and openness

We describe our sampling plan and all data exclusion criteria below under the sample heading. In the current study, we used Brislin's (1980) proposed process was followed to maintain the similarity of the content and meanings of original and translated versions and we adhered to the *Journal of Psychological Assessment* methodological checklist. Analysis and research material including Urdu translated version of DSQ–40 and SPSS sheet were available on demand as this article is part of PhD dissertation. Data were analyzed by using SPSS version 22. The study design was purposive and its procedure was written in detail in the procedure section below.

PHASE I: TRANSLATION OF DSQ–40

Phase I was carried out to translate DSQ–40 in Urdu language to bring conceptual equivalence to the original English version of the scale. Permission was taken from the Authors of DSQ–40 (Andrew et al., 1993) for translation and validation of the scale. After that, Brislin's (1980) proposed process was followed to maintain the similarity of the content and meanings of original and translated versions. The process was divided into following three steps.

Phase I: Forward translation

The DSQ–40 was translated from English to Urdu by four bilingual experts (associate and assistant professor of linguistics and psychology from Government College University, and Kinnaird College for Women, Lahore). These bilingual experts were proficient in both languages, and were familiar with the Western culture as well. Experts were instructed to follow the technical uniformity of language such as grammar, question length, relationship to socio–cultural context, acceptable level of abstraction and tenses in translation and adaptation of each item according to Pakistani culture, without eliminating the items. In the end, there were four independent Urdu translations of DSQ–40 for further processing.

Phase I: Reconciliation of items

After getting translations of DSQ–40, four independent Urdu translated version of each items were reconciled by comparing them in order to assess the theoretical similarities of items by using a committee approach. The committee consists of four members (a professor and an assistant professor of Psychology, and two lecturers in Psychology from Women University, Multan and Government College University, Lahore). Each item was vitally evaluated and assessed by experts and they selected the best meaningful Urdu translation, which fulfilled the criteria of clear context, grammar and wording. After finalizing the finest Urdu translated items, proof reading was done to get the final print out.

Phase I: Backward translation

This step was performed to ensure that Urdu translated versions of DSQ–40 were suitable, reliable, correct and valid without linguistic biases. So, the finalized version of Urdu scale (DSQ–40) were translated back into English by a bilingual expert independently, who was unfamiliar with the original scale. The bilingual expert was provided with the final translated version of Urdu scale to translate it back into English language to ensure that Urdu translated version was correct and without linguistic biases. Back translation was done to validate the conceptual and linguistic similarity of the Urdu translated scale with the original one.

PHASE II: CROSS LANGUAGE VALIDATION

In the second phase of the current study, cross language validation was established by measuring correlation between three versions (Original, Urdu and Backward) of DSQ–40.

Phase II: Sample

A purposive sample (N = 60) with equal distribution of both parents of a child with ASD (father = 30 and mother = 30) was recruited from different autism centers of Lahore. Only those parents were included who had a child diagnosed

with ASD of age ranged between 4–12 years, and they were fluent in both Urdu and English languages. Parents who were living together and belonged to middle and high socioeconomic status took part in the study. Parents of a child with ASD along with any other co morbid disorder were not included in the study.

Phase II: Procedure

This phase of the study was intended to examine the cross language validation of the translated version of scale (DSQ–40). All three versions of the scale were administrated on three groups of parents in terms of order of administration of three versions (20 parents in each group). The order of administration was: Group 1: Original English, forward Urdu and backward English; Group 2: backward English, forward Urdu and original English; Group 3: forward Urdu, backward English and original English. Only 20 parents (10 fathers and 10 mothers = 20) were called in a day for the administration of three versions of DSQ–40scale because the sample was challenging. The parents were given three versions after an interval of one hour in three different orders to control the carry over effect due to same order of administration of all three versions of the scale.

Table 1 shows that all versions of DSQ–40 significantly correlate with each other and their pair wise correlation ranged from (.98 to .99). Hence the results show that the content of Urdu version of DSQ–40 is statistically equivalent to the original English version.

PHASE III: MEASUREMENT OF PSYCHOMETRIC PROPERTIES

In phase III, psychometric properties of the translated version of the scale were established.

Phase III: Sample

A purposive sample of three hundred and fifty (N = 350) with equal distribution of parents (175 mothers and 175 fathers) was recruited from different autism centers of Punjab, Pakistan and via social media. Only those parents were included who had a child diagnosed with ASD of age ranged between 4–12 years. Parents who were living together and belonged to middle and high socioeconomic status took part in the study. Parents of a child with ASD along with any other co morbid disorder were not included in.

Table 1 – Inter–correlations among original, Urdu and English versions of DSQ–40 (N = 60)

Scale	1	2	3
1. Urdu forward	–		
2. Backward English	.99**	–	
3. Original English	.99**	.98**	–

**p<.01

Phase III: Procedure

Prior to administration of the scale, three hundred and fifty (N = 350) parents (175 mother and 175 fathers) were contacted and approached in person, on a time and place fixed with the consent of both parents for administrating the scale. After that, consent form was signed and the parents were briefed about the purpose of the study and assured that their responses would be kept confidential. They were told that there was no right or wrong answers. There was no time limit to fill the questionnaire and it took 20 to 25 minutes to read and respond the items of scale. Data were analyzed by using AMOS 22.0.

Phase III: Results

– *Confirmatory factor analysis*. Confirmatory factor analysis was run in order to validate the factor structure of Urdu translated measure, to ensure the likelihood and perfection of the scale according to Pakistani culture.
Table 2, Table 3 and Figure 1 represent the findings of the original model with three factor structure of DSQ–40. Confirmatory factor Analysis was run on Urdu translated DSQ–40 to get the best factor loadings and model fit indices. The initial criteria for the item loading is >.35. The final model of three factor structure shows the good model fit (χ^2 = 2159.01 (df = 731); p = .000; χ^2/df = 2.95; RMSEA = .05; GFI = .92; AGFI = .90; TLI = .91 and CFI = .93). Generally, a good model fit requires a non–significant chi–square; however when dealing with a large data set, the value of chi–square is nearly always significant. In such cases, Hatcher (1996) suggests that a model that has a value less than 3, when the value of chi–square is divided by the degrees of freedom, is a good fit. So, it is 2.95 which come under the acceptable range. Further, RMSEA should be below .05, which are showing a good fit model and in recommended range. Moreover, the final model is acceptable, the factor loadings of the items ranged from .35 to .95.
– *Reliability analysis*. In order to assess the reliability of the translated version of scale, Cronbach's alpha and inter–correlations among the sub–scales were calculated.
Table 4 indicates that three subscales of DSQ–40 have good Cronbach's alpha reliability values ranging from .81 to .94. Further correlations among three subscales are significantly correlated with each other (r = –.87, r = –.80, r = .77, p<.01) that support the reliability of the Urdu translated version of the scale.

PHASE IV: TESTING THE USES OF DEFENSE MECHANISM

In phase IV we investigate the relationship of demographic variables (education, income, and age) and uses of defense mechanism among parents of children with ASD and find out the group differences in using defense mechanism among parents of children with ASD.

Phase IV: Hypotheses

1. There are significant relationship of demographic variables (gender, age, income and education) and uses of defense mechanism among parents of children with ASD.
2. There are gender differences in uses of defense mechanism among parents of children with ASD.
3. Parents of children with autism spectrum disorder significantly differ on uses of defense mechanism in terms of different education levels.
4. Parents of children with autism spectrum disorder significantly differ on uses of defense mechanism in terms of different income groups.

Phase IV: Sample

A purposive sample with snowball technique was used, where six hundred (N = 600) with equal distribution of parents (300 mothers and 300 fathers) was recruited from different cities of Punjab, Pakistan. Only those parents were included having a child with ASD and already diagnosed. The child's age ranged from 4 to 12 years old was included and both parents were living together since the birth of a child.

Phase IV: Instruments

In this study, Urdu version of DSQ–40 was administered: its reliability is .89 which is good reliability. Originally, *Defense Style Questionnaire – 40* constructed by Andrews et al. (1993). It is clustered in three subscales and comprises 40 items using

Table 2 – The factor loadings of Confirmatory Factor Analysis on DSQ–40 (N = 600)

Subscales	Item no.	Factor I Mature	Factor II Neurotic	Factor III Immature
Sublimation	3	.91		
	38	.43		
Humor	5	.84		
	26	.40		
Anticipation	30	.35		
	35	.95		
Suppression	2	.83		
	25	.89		
Undoing	32		.60	
	40		.51	
Altruism	1		.74	
	39		.55	
Idealization	21		.59	
	24		.60	
Reaction formation	7		.45	
	28		.53	
Projection	6			.77
	29			.71
Passive aggression	23			.80
	36			.50
Acting out	11			.80
	20			.83
Isolation	34			.79
	37			.79
Devaluation	10			.48
	13			.71
Autistic fantasy	14			.81
	17			.50
Denial	8			.82
	18			.46
Displacement	31			.79
	33			.49
Dissociation	9			.50
	15			.55
Splitting	19			.45
	22			.89
Rationalization	4			.36
	16			.48
Somatization	12			.76
	27			.40

Table 3 – Model fit indices of CFA for DSQ–40 (N = 350)

Indices	χ^2	*df*	χ^2/df	*p*	GFI	AGFI	TLI	CFI	RMSEA
Model 1	2205.27	733	3.00	.000	.89	.87	.86	.88	.06
Model 2	2159.01	731	2.95	.000	.92	.90	.91	.93	.05

Legenda. df = degree of freedom; GFI = Goodness of Fit Index; AGFI = Adjusted Goodness of Fit Index; TLI = Tucker–Lewis Index; CFI = Comparative Fit Index; RMSEA = Root Mean Square Error of Approximation.

a 9–point Likert format that derive 20 different defenses (2 items per each). Mature factor includes (anticipation, humor, sublimation, and suppression), Neurotic includes (pseudo–altruism, idealization, reaction formation, and undoing and Immature factor include (acting out, denial, devaluation, displacement, dissociation, autistic fantasy, isolation, passive aggression, projection, rationalization, somatization, and splitting). DSQ–40 score range from 40 to 354.

Phase IV: Procedure

The study intended to examine the relationship between demographic and use of defense mechanism. Before collecting the data, permission was taken from the author of scale through email. After seeking permission, approval of data collection was taken from relevant institutions, centers for autism, and clinics. Before administration of the scale, parents were contacted in person, permission was taken and time for data collect was fixed when both parents were available and can visit clinic or center. Informed consent was signed by each parent and they were informed that if they found difficulty and any problem while completing the questionnaires, they could easily withdraw. After that, each parent was briefed about the study and questionnaire and assured that their responses and given information would be kept confidential. The autism rating scale (CARS) was administered to find out the severity of illness of every child. After that, each parent filled DSQ–40. There was no time limit to fill the questionnaire. Initially, 300 forms were distributed and 220 forms were returned, in which only 182 forms were found complete and other 38 forms were discarded. Then we use autism resource group on Facebook for further data collection. In total, 516 parents were contacted in person, permission was taken and time for data collection was fixed when both parents were available and can easily visit autism center of Lahore. After that, 418 forms were found completed by both parents and 98 forms were discarded due to incomplete information and it was filled by single parent. So, the analysis was carried out on a sample of 600 parents. The scores on each item were entered in Statistical Package for the Social Sciences (SPSS) version 22.0 for Windows. Where a significant difference was displayed on ($p<.05$ or $p<.01$).

RESULTS

Frequencies and percentages

Demographic data sheet covered demographics like: parental age, monthly income, education, number of children with ASD, child age, gender, and birth order. The responses to the questions are listed below with their frequencies and percentages.

Table 5 explains the demographics characteristics of the sample. Though the sample was purposive and selected on the basis of convenience of the researcher. Still demographic data appear to be comparable on most of the variables, except some of the variables (e.g., gender of child, no of children with ASD, birth order of a child with ASD).

Figure 1 – Path diagram for the Urdu version of Defense Style Questionnaire – 40

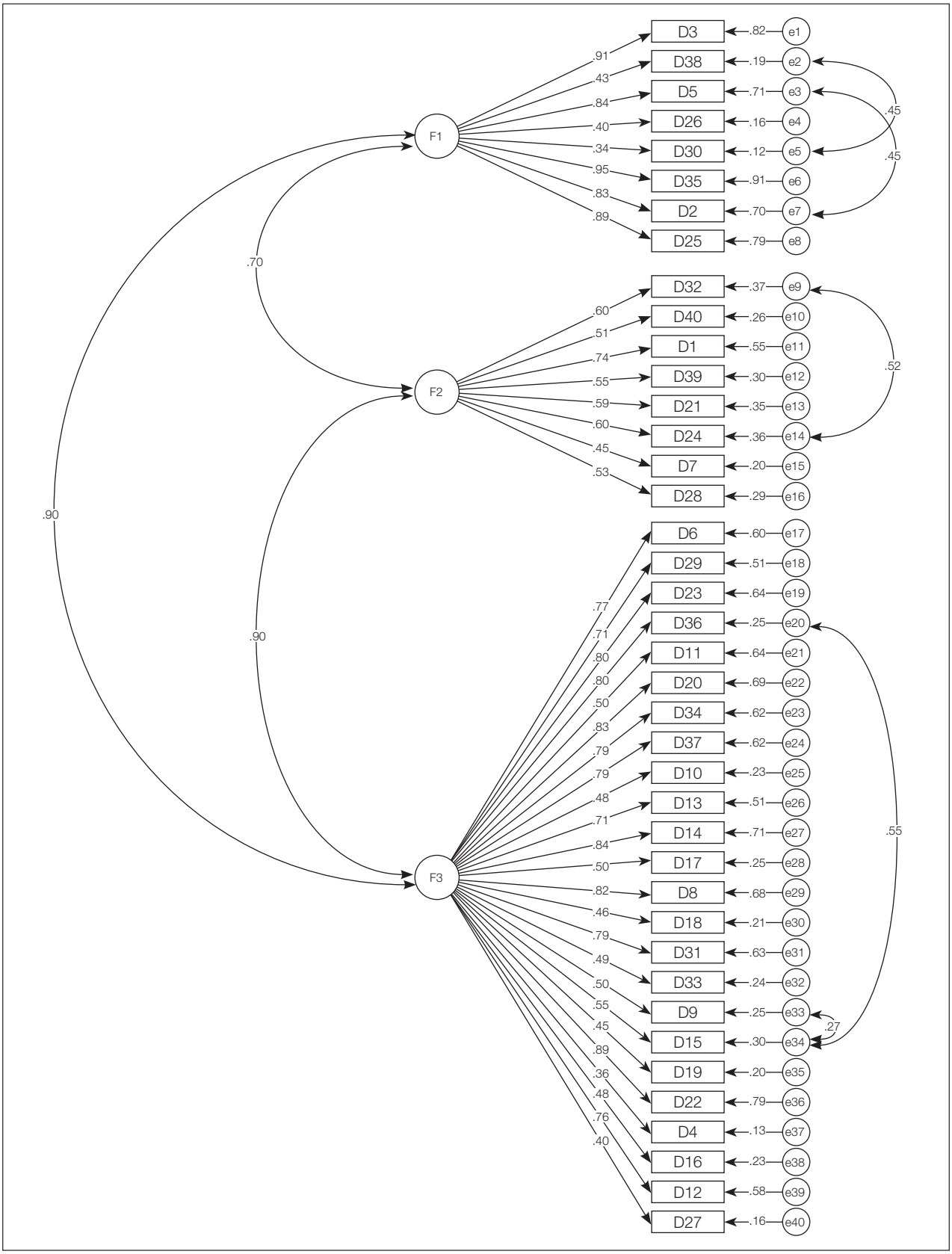


Table 4 – Means, standard deviations, alpha reliability and inter–correlations among DSQ–40 subscales (N = 350)

									Rang	
Subscale	*K*	*M*	*SD*	α	1	2	4	4	Actual	Potential
1. Mature	8	40.0	16.1	.88	–	–.68**	–.84**	.89**	8–64	8–72
2. Neurotic	8	39.0	14.4	.81		–	.83**	.87**	8–64	8–72
3. Immature	24	119.3	43.8	.87			–	.98**	24–188	24–216
4. Total scale	40	198.4	70.4	.89				–	40–314	40–360

**$p<.01$

Correlation

In order to see the relationship between demographic variables and uses of defense mechanism Pearson's product moment coefficient of correlation was used. Further, to test the relationship of defense mechanism among parents, we use total scale score, separate individual three factors scores and separate twenty defenses scores to find out which defense was used by both parents in raising a child with ASD.

Table 6 shows, correlation between demographics (gender, income, education, parental age, children with ASD, gender of child, child age and birth order of child) and defense mechanism. Gender significantly correlates with defense mechanism (r = .13**) and its three factors Mature (r = .17**), Immature (r = .12**) and Neurotic (r = .13**) defense mechanism. Further, income significantly negatively correlates with defense mechanism (r = −.19**), Mature (r = −.10*), Immature (r = −.11**) and Neurotic (r = −.18**). Furthermore, significant no relationship found between parental age, no of children with ASD, gender of child and birth order of child with defense mechanism. Results indicate that gender play significant role among parents in uses of defense mechanism as coping in having a child with ASD. Level of income of single family in having a child with ASD also play an important role.

Table 7 shows, correlation between demographics (gender, education, income and age) and twenty defense mechanisms. Gender significantly correlates with Sublimation (r = .21**), Undoing (r = .08*), Altruism (r = .12**), Reaction formation (r = .12**), Passive aggression (r = .12**), Acting out (r = .08*), Devaluation (r = .17**), Denial (r = .14**) and Dissociation (r = .15**). Further, Education is only negatively correlates with Devaluation (r = −.09*). Moreover, income negatively correlates with Sublimation (r = −.13**), Altruism (r = −.12**), Undoing (r = −.10**), Reaction formation (r = −.10*), Passive aggression (r = −.10**), Devaluation (r = −.14**), Denial (r = −.13**) and Dissociation (r = −.10**). Furthermore, age has significant no relationship with any defense mechanism. Result revealed that gender have significant positive relationship between certain defense mechanisms, which mean both parents try to hide their feelings by using reaction formation in diagnosis of their child. They try to control their unacceptable impulses by converting their behavior in acceptable form. They try to cope with stress by indulging their self in different activities and helping others to satisfying their internal needs or removing the bad experiences by using indirect anger toward others to stabilize their self–esteem. Similarly, education and income somehow help them positively and negatively by accepting the issues in stabilizing their feelings toward envy or some fear of loss by stabilizing their self–esteem.

Table 5 – Number and percentage of demographic variables used in study (N = 600)

Variables	Frequency	Percentage
Parent age		
Young age parents (18–34)	358	59.7
Middle age parents (35–45)	242	40.3
Education		
Schooling or less	94	15.7
College	253	42.2
University	253	42.2
Monthly income		
49,000 or less	257	42.8
50,000–99,000	204	34.0
100,000 or above	139	23.2
No of children with ASD		
1	564	94.0
2	36	6.0
Age of children with ASD		
4–7 years old	400	66.6
8–12 years old	200	33.3
Gender of child		
Boy	314	52.3
Girl	276	46
Twin	10	1.7
Birth order of child		
First born	502	83.7
Other	98	16.3

Table 6 – Pearson's product moment coefficient of correlation between the demographic and defense mechanism and its three factors (N = 600)

Demographics	Study variables			
	Defense mechanism	Mature	Immature	Neurotic
1. Gender	.13**	.17**	.12**	.13**
2. Education	–.05	–.04	–.03	–.06
3. Income	–.19**	–.10*	–.11**	–.18**
4. Parental age	–.03	–.03	–.02	–.04
5. No of children with ASD	–.04	–.07	.08	–.01
6. Gender of child	–.01	–.03	–.03	–.03
7. Child age	–.02	–.05	–.01	.02
8. Birth order of child	–.07	–.05	.03	.02

**p<.01, *p<.05

Independent sample *t*–test

Independent sample *t*–test was run to see the gender differences. Mean and standard deviations of the variables also used in the analysis are list below.

Table 8 shows, the result of independent sample *t*–test and mean and standard deviation of defense mechanism and its three factors (Mature, Neurotic and Immature). The results shows that mothers score higher on use of defense mechanism compared to father.

In order to examine the mean differences in term of income with reference to defense mechanisms three factors a multivariate analysis was conducted. MANOVA help in looking dependent/outcome variables simultaneously by detecting the effect of groups across the combination of variables (Field, 2013). In order to test the assumptions of MANOVA a series of correlation were run between all the variables (see Table 6), where correlation with each other show a moderate range except few variables i.e., parental age, child birth order etc. so, we excluded these variables. For further, analysis of difference the measure of percent variance (Wilks's lambda) was analyzed (see below Table 9) and demographic variable i.e., income entered into MANOVA for analysis with a logical sequence.

Table 9 shows that income significant demographic variable in relation with defense mechanism uses. The detail of multivariate analysis results was explained with adjacent table of univariate analysis (see interpretation of Table 10).

The multivariate analysis result shows the main effect of income on defense mechanism is significant, Wilk's $\lambda = .97$, $F_{(6,\ 1190.0)} = 2.06$, *p<.05, $\eta^2 = .10$. The power to detect the effect was .75 (see Table 9).

Table 10 shows the result of univariant test, it indicated the main effect of income on uses of defense mechanism is significant: Mature $F_{(2,599)} = 3.11$, *p<.05, Neurotic $F_{(2,599)} = 5.01$, *p<.05, and Immature $F_{(2,599)} = 3.77$, **p<.01. Therefore, its mean families with lower income, middle

Table 7 – Pearson's product moment coefficient of correlation between the demographic and defense mechanisms (N = 600)

Var	Ge	Ed	Inc	Pag	Sub	Hum	Ant	Sup	Und	Alt	Id	Ref	Pro	Paa	Aot	Iso	Dev	Afy	Den	Dip	Dis	Spl	Rat	Som
1. Ge	1	−.02	−.63**	.00	.21**	.02	−.04	.08	.08*	.12**	.01	.12**	−.01	.12**	.08*	.01	..17**	.03	.14**	.01	.15**	.03	.05	−.05
2. Ed		1	.32**	−.02	−.04	−.03	−.03	−.02	−.05	−.03	−.02	−.07	−.04	−.02	−.02	.09	−.09*	.05	.01	−.03	−.05	−.03	.07	.01
3. Inc			1	.05	−.13**	−.04	−.02	−.06	−.10**	−.12**	−.05	−.10*	−.03	−.10**	−.08	−.03	−.14**	−.03	−.13**	−.04	−.10**	−.03	−.07	−.09
4. Pag				1	.04	−.04	−.04	−.05	−.07	−.05	.03	−.05	−.02	−.01	−.05	−.01	.03	−.04	−.03	−.01	.01	−.02	.04	−.07
5. Sub					1	.25**	.26**	.36**	.14**	.17**	.18**	.17**	.22**	.28**	.34**	.23**	.35**	.18**	.35**	.17**	.29**	.30**	.14**	.15**
6. Hum						1	.27**	.42**	.26**	.19**	.25**	.24**	.33**	.32**	.26**	.18**	.23**	.26**	.36**	.20**	.19**	.34**	.18**	.29**
7. Ant							1	.22**	.11**	.07	.11**	.13**	.24**	.12**	.30**	.32**	.14**	.24**	.18**	.10**	.05	.12**	.04	.32**
8. Sup								1	.28**	.26**	.17**	.22**	.33**	.35**	.32**	.19**	.34**	.28**	.42**	.22**	.24**	.44**	.16**	.17**
9. Und									1	.36**	.48**	.49**	.29**	.37**	.03	.01	.43**	.42**	.39**	.46**	.38**	.45**	.46**	.06
10. Alt										1	.31**	.34**	.19**	.33**	.14**	−.01	.37**	.27**	.36**	.36**	.30**	.38**	.32**	.07
11. Id											1	.53**	.29**	.29**	−.03	.05	.42**	.42**	.41**	.52**	.29**	.35**	.52**	.08*
12. Ref												1	.22**	.32**	−.01	.10**	.43**	.41**	.41**	.50**	.35**	.37**	.50**	.11**
13. Pro													1	.36**	.20**	.10*	.29**	.32**	.25**	.27**	.27**	.33**	.29**	.24**
14. Paa														1	.19**	.01	.41**	.28**	.42**	.39**	.40**	.43**	.31**	.06
15. Aot															1	.26**	.24**	.15**	.19**	.03	.14**	.16**	−.07	.22**
16. Iso																1	.14**	.27**	.20**	−.02	−.01	.01	.05	.34**
17. Dev																	1	.38**	.41**	.39**	.43**	.41**	.40**	.09*
18. Afy																		1	.37**	.41**	.30**	.35**	.44**	.29**
19. Den																			1	.38**	.26**	.37**	.35**	.11**
20. Dip																				1	.33**	.41**	.53**	.15**
21. Dis																					1	.33**	.33**	.03
22. Spl																						1	.39**	.09*
23. Rat																							1	.10*
24. Som																								1

Legenda. Ge = Gender; Ed = Education; Inc = Income; Pag = Parental age; Sub = Sublimation; Hum = Humor; Ant = Anticipation; Sup = Suppression; Und = Undoing; Alt = Altruism; Id = Identification; Ref = Reaction formation; Pro = Projection; Paa = Passive aggression; Aot = Acting out; Iso = Isolation; Dev = Devaluation; Afy = Autistic fantasy; Den = Denial; Dip = Displacement; Dis = Dissociation; Spl = Splitting; Rat = Rationalization; Som = Somatization.

**p<.01, *p<.05

Table 8 – Independent sample *t*–test, means and standard deviations score of variables of study (N = 600)

Variables	*M*	*SD*	*t*	*p*	95% CI	
					Lower	Upper
Defense mechanism	193.6	46.3	−3.27	.01**	−19.69	−4.92
Father	187.5	62.74				
Mother	199.8	17.23				
Mature	39.0	11.08	−2.62	.04*	−4.13	−.597
Father	37.8	13.7				
Mother	40.2	7.44				
Neurotic	38.3	13.1	−2.79	.05*	−5.07	−.883
Father	36.8	16.9				
Mother	39.8	7.49				
Immature	116.3	28.5	−3.00	.03*	−11.50	−2.41
Father	112.8	37.8				
Mother	119.8	13.2				

*p<.01, *p<.05

Table 9 – Multivariate effects on Defense mechanism (N = 600)

I.V.	λ	*F*	*df*	*Error df*	*p*	η^2	*Power*
Income	.97	2.06	6	1190.0	**.05***	.10	.75

Legenda. df = degree of freedom.
Note. Table 9 present the results of multivariate analysis of the income of current study.
*p<.05

Table 10 – Group difference on study variables in term of parents income (N = 600)

Variable	DVs	*SS*	*df*	*MS*	*f*	*p*	η^2
Income	Mature	759.6	2	379.8	3.11	.04*	.01
	Neurotic	1711.0	2	855.5	5.01	.05*	.01
	Immature	3047.117	2	3047.1	3.77	.02**	.01

Legenda. df = degree of freedom.
*p<.05, **p<.01

income and upper income had significant effect on uses of defense mechanism among parents in raising a child with ASD. The post hoc test analysis revealed that lower income families use more defense mechanism than other income levels (see Figure 2)

Reporting multiple a priori comparisons

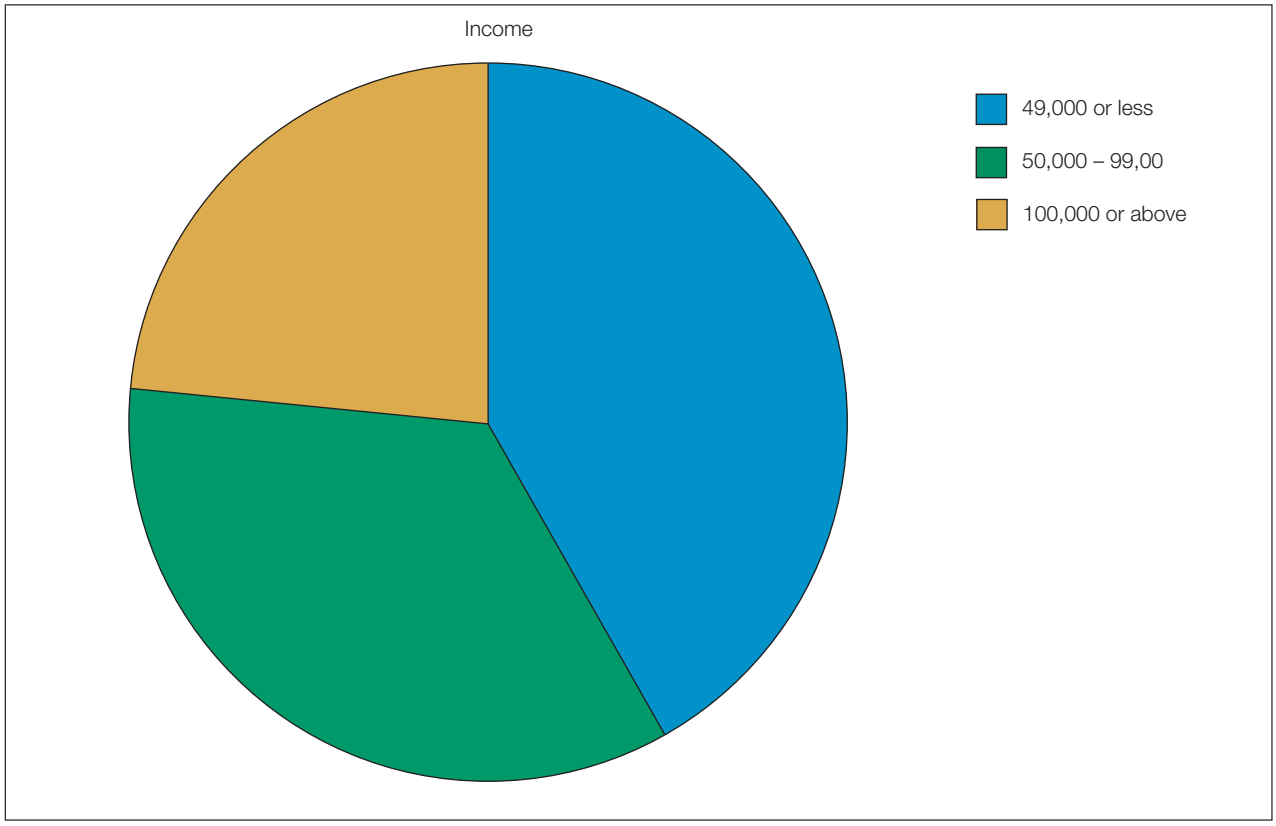
Tests of three a priori hypotheses were assessed using three independent groups *t*–tests with a Bonferroni adjusted alpha level of .016 per test (.05/3). Results suggest that the parents of children with ASD having lower income (M = 39.99, SD = 9.45) was significantly higher in use of Neurotic defense mechanism than the middle income (M = 37.98, SD = 13.86) and upper income (M = 35.68, SD = 17.01), $t_{(599)} = -81.48$, SEM = .457, p = .007. Further, parents of children with ASD having lower income (M = 119.3, SD = 21.48) was significantly higher in use of Immature defense mechanism than the middle income (M = 115.9, SD = 28.46) and upper income (M = 111.20, SD = 37.95), $t_{(599)} = -67.38$, SEM = .541, p = .02. However, parents of children with ASD having lower income (M = 40.24, SD = 9.60) was significantly higher in use of Mature defense mechanism than the middle income (M = 38.61, SD = 10.66) and upper income (M = 37.46, SD = 13.77), $t_{(599)} = -97.98$, SEM = 1.168, p = .04. Therefore, parents of children with ASD having lower income uses more defense mechanism than the parents of middle or upper income level.

DISCUSSION

Most of the translation and validation studies of DSQ suggest that it is a reliable and valid tool for use on various populations. But it has appeared to be more useful in clinical assessments. Every person around the world undergoes through different stresses and they use defenses as a coping to protect themselves from conflicts. Moreover, people's perception in use of defense mechanism may be possibly prejudiced by different traditions and community. In early validation and translation studies of DSQ–40, the correlation of defenses was checked among students, adolescents, professionals and forensic departments, but neglected to test on parents having a child with any neurodevelopmental condition. So, in this study the focus was on cross–cultural and conceptual equivalence and gender difference in using defenses among parents having a child with a neurodevelopmental condition (ASD). Brislin's (1980) translation process was used to maintain the similar meanings of instrument in original and translated versions, since translation into another language or culture, demands a careful methodology when dealing with psychometric measures (Meyer et al., 2003). The empirical equivalence of the translated Urdu version was assessed by the finding the inter–correlations among original, forward and backward translated versions of DSQ–40. All versions were significantly positively correlated (see Table 1).

Further, confirmatory factor analysis was run to ensure the original factor structure of three subscales of DSQ–40 and model fit to the data obtained from parents of children

Figure 2 – Pie chart of income level in use of different defense mechanism



with ASD in the context of Pakistan. Based on the reported goodness of fit indices the CFA of three factor structure DSQ–40 was empirically supported (see Figure 1 and Tables 2–3). The results not only showed good model fit indices, but also supported the factor structure of the original scale (Cottle, Gannon & Christmas, 2017; Thygesen et al., 2008).

The findings of reliability analysis and correlation matrix of sub–scales of Urdu translated version of DSQ–40 support that the scale is reliable (see Table 4). Results are similar to Andrews' findings (Andrews et al., 1993). In comparison to other studies aimed at translation of DSQ–40 in Romanian, Greek, Arabic, Brazilian and Japanese version (e.g., Blaya et al., 2004; Soliman, 1997), the internal consistency for the DSQ–40 Urdu version is superior. The correlations between the subscales were also statistically significant and the overall scores maintained the results of previous researches, and showed that Urdu version of DSQ–40 is appropriate to be used in the context of Pakistan, especially with parents of children with ASD.

Further, correlation analysis was run to test the relationship of demographic variables and defense mechanism among parents of children with autism spectrum disorder. The result of correlation demonstrated that gender and income had significant relationship with defense mechanisms. Parents use different defense mechanisms to hide their feelings by using reaction formation in diagnosis of their child. They try to control their unacceptable impulses by converting their behavior in acceptable form. They try to cope with stress by indulging their self in different activities and helping others to satisfying their internal needs or removing the bad experiences by using indirect anger toward others to stabilize their self–esteem. Similarly, Gray and Holden (2013) and Koegel and colleagues (1992) reported when stigma by association is directly link to parental stress, it automatically increases the stress level in parents while interaction with family, friends or colleagues and its also effect parents daily activities and lead them to use different defenses as coping (Siman–Tov & Kaniel, 2011; Taati & Bahri, 2019).

Moreover, in current study mother use more defense mechanism than fathers. The findings are consistent with Abbasi and Pirani (2017) reported that mothers of deaf children and children with intellectual disability used more defense mechanism than fathers. Keeping in view the inconsistency of results on gender differences in the use of defense mechanisms, Watson and Sinha (1998) recommended that specific norms of DSQ–40 needed to be reconstructed with regards to gender.

Further, MANOVA result showed that lower income families use more defense mechanism as the economic and monetary burden is considered as a contributing factor (Karst & Van–Hecke, 2012) as yearly expenditures in taking care and raising a child with ASD are significantly very high than those for non–affected children (Croen, Najjar, Ray, Lotspeich & Bernal, 2006). Parents are at high risk of being not employed and having financial issues in taking care of children with special health problems (Heck & Makuc, 2000; Kuhlthau et al., 2014; Kuhlthau & Perrin, 2001). Furthermore, Kuhlthau et al. (2014) reported that parent's health affected by direct and indirect financial strain in parenting a child with ASD. Overall, half of the parents had reported financial problems, and combining care tasks with daily activities affected their performance in the office and they faced difficulty in maintaining a job. These issues were considered important, as they had reduced family income and social connection between the two parents.

Implications

Translated DSQ–40 in Urdu language will help health professionals and clinical psychologist in Pakistan to find out which coping mechanism was used by parents of different neuro development conditions or people who need psychological help. As defense mechanism put positive or negative impact on lives of people who need psychological help. So Urdu version of SDQ–40 will help in hospitals for enhancement of psychodynamic research on patients and their care givers. This translated version of DSQ–40 will open new vistas of research on defense styles in the field of health psychology and interpersonal and marital relationships in Pakistan.

Limitation and suggestions

Only parents of children with ASD were taken as a sample for determining the psychometrics of DSQ–40, so further validity studies for Urdu version should investigate the validity and reliability of the scale by involving family members and parents of children with other disabilities and mental disorders. Further, investigation on validity of the Urdu translated DSQ–40 with subject to age range, income and education 600 parents were included form Punjab province so further data should be collected from different provinces of Pakistan to demonstrate the inter–province variations. We only use demographic variables so further other variables like family structure, sibling relationship, parental stress etc. need to be explored. Further, parents are living in urban areas were taken which is not enough. For, comparative analysis both areas urban and rural should be included for future research direction. Cross–cultural and longitudinal studies should need to be conducted as they will be beneficial for therapists and doctors to find out whether defense mechanisms are risk or protective for parents in raising a child with autism spectrum disorder. In the present study only those parents were included who are married and living together. Single and divorced parents also need to be explored in future research.

CONCLUSION

Based on the present results, we conclude that the Urdu translated version of DSQ–40 is a highly valid and reliable measure and we may continue to use it with parents having a child with ASD, other disabilities, or a person with mental health issues in Pakistan. The results of the study have not only support the original three factor structure of DSQ–40, but also indicate that Urdu translation is superior to the translation done in other languages in terms of cross language validation and scores on reliability measures.

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Using an online tool to support job crafting behavior among workers with disabilities: An exploratory study

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ABSTRACT. Questo studio ha esaminato l'impatto dell'applicazione JOS, un nuovo strumento che stimola e facilita il job crafting attraverso la tecnologia di comunicazione online. È stato condotto uno studio pre e post intervento senza gruppo di controllo: l'intervento, della durata di 5 settimane, ha previsto brevi esercizi di job crafting per riflettere su se stessi e sul proprio lavoro, sull'adattamento tra questi due aspetti e sulle possibili strategie di job crafting per migliorare questo adattamento. I punteggi ottenuti mettono in evidenza che il comportamento proattivo potrebbe non avere alcun effetto – o addirittura negativo – nel breve termine, ma effetti positivi nel lungo termine.

SUMMARY. This study examined the impact of the JOS app, a new tailored web–based job crafting intervention tool that aims to make job crafting more accessible to workers with disabilities. The JOS app has been developed as a self–guided online tool that stimulates and facilitates job crafting through micro–interventions (i.e. without intensive contact with a trainer or coach, but through online communication technology). We expected that the intervention would have a positive impact on participants' job crafting behaviors. In addition, we expected a positive influence of the intervention on their job satisfaction and perceived employability. A pre– and post–intervention study without control group was conducted. The 5–week intervention includes brief job crafting exercises to reflect upon themselves (e.g. abilities, energy eaters and givers) and their work, the fit between those two, and to think about possible job crafting strategies to improve this fit. Using the JOS app has led to more job crafting behavior among participants. Scores on both job satisfaction and perceived employability remained virtually unchanged. This is consistent with previous suggestions that proactive behavior might not have any effects at all, or even negative ones, in the near term, but positive effects in the long term.

Keywords: *Job crafting, JOS app, Workers, Disability*

INTRODUCTION

The Belgian statistical office Statbel reports that 9% of people aged 15 to 64 have a handicap or health issue that significantly restricts their everyday activities. Due to these restrictions, only 26% of them are employed, compared to 65% of the general population. They have an unemployment rate that is 3 percentage points greater than the general population, and 74% of them are inactive, meaning they are not looking for work or are not available for it (Statbel, 2018). To close the disability employment gap, the government invests in strategies to support people with disabilities to move into employment. Supporting people with disabilities in finding work is important and necessary. At least as important and necessary is to make sure that they are employed in a 'good' job (i.e. a job that fits their strengths, skills, interests, preferences, and needs related to employment) so they can remain at work. Unfortunately, that is not always the case (Bourdeaud'hui, Janssens & Vanderhaeghe, 2021). It's up to employers to step up and make workplace accommodations and/or provide extra support. For this purpose, employers can rely on the advice and guidance from service providers and if necessary, apply for funding support. In addition, workers with disabilities may also proactively take the initiative to change their existing job for it to better suit their personal strengths, skills, interests, preferences, and needs. This self–initiated proactive behavior is known as job crafting (Wrzesniewski & Dutton, 2001).

Previous research by Brucker & Sundar (2020) shows that employees with disabilities, compared to employees without disabilities, participate less in job crafting behaviors. Although job crafting concerns employees' self–initiated behaviors, organizational interventions can support or encourage these proactive behaviors (Gordon et al., 2018). There is growing evidence that job crafting interventions, such as one–day training interventions and online workbooks, can increase employee job crafting behavior (Devotto & Wechsler, 2019). But since the interventions and tools for job crafting currently in use are designed for the general population, they probably need to be modified to address the unique needs of workers with disabilities (Brucker & Sundar, 2020).

Job crafting

Job crafting was first introduced by Wrzesniewski & Dutton (2001). They defined job crafting as "the physical and cognitive changes individuals make in the task or relational boundaries of their work" (p. 179). Changing task boundaries refers to altering the type, scope, number, or sequence of tasks (task crafting). For example, they can choose to simplify tasks to make them less intense and taxing where possible or to remove tasks that do not suit to their abilities. Changing relational barriers means altering and shaping the relationships with other people at work and the activities that it carries out with the co–workers (relational crafting). Employees may seek out or create opportunities to interact with others at work, fostering new connections and maintaining existing ones. But they may also intentionally spend less time with individuals they do not like. Changing cognitive task boundaries entails re–framing how employees perceive their work (cognitive crafting) (Wrzesniewski & Dutton, 2001). This includes reflecting on the value, meaning and significance of our work activities for the organization, and for others, such as our customers, clients, or wider society. Two more types of job crafting behavior were later added: contextual crafting and time and spatial crafting. Contextual crafting refers to employees who alter the workplace or work environment (Sanders, Dorenbosch, Grundemann & Blonk, 2011), whilst time and spatial crafting refers to employees who analyze and choose the most suitable time and place to work (Wessels et al., 2019).

Tims & Bakker (2010) enriched the theoretical background by framing job crafting within the Job Demands–Resources (JD–R) model (Bakker & Demerouti, 2007) and fit. The JD–R model is used to investigate predictors of employee well–being, engagement, and individual and organizational outcomes. According to the model, job characteristics can be divided into two categories: job demands and job resources. Job demands typically result in job strain that necessitates an effort to cope (e.g., workload and time constraints), whereas job resources aid in goal attainment and are associated with personal growth (e.g. performance feedback and task variety). As a result, job resources serve as an important buffer against the psychological costs associated with job demands (Bakker & Demerouti, 2017). Employees can modify their jobs to better fit their talents, abilities, preferences, and needs by increasing or decreasing job demands and job resources, allowing them to maintain motivation and protect their well–being (Wessels et al., 2019). Petrou and colleagues (Petrou, Demerouti, Peeters, Schaufeli & Hetland, 2012) define job crafting therefore as "proactive employee behavior consisting

of seeking resources, seeking challenges, and reducing demands" (p. 501).

According to earlier research, job autonomy enables employees to flexibly schedule their work, make decisions, and select methods used to perform tasks to satisfy their needs (Li, Han, Qi & He, 2020). Employees have the freedom, discretion, and independence to actively craft their jobs according to their unique preferences, needs, and abilities thanks to job autonomy (Rudolph, Katz, Lavigne & Zacher, 2017; Wrzesniewski & Dutton, 2001).

Motives for crafting work

Employees engage in job crafting for different reasons (Wrzesniewski & Dutton, 2001). Lazazzara, Tims and De Gennaro (2020) observed in a recent meta–synthesis of qualitative job crafting research that those reasons can be of two types: proactive and reactive motives. Proactive motives refer to employees wanting to initiate job crafting to reach desirable goals (e.g. more control over their own actions, a more positive self–image, better relationships with colleagues or customers, a better work–life balance, and the ability to use talents), while reactive motives are related to the need to cope with or reduce negative aspects of work (e.g., lack of autonomy, role ambiguity, and job insecurity) (Lazazzara et al., 2020). Job crafting with a proactive motivation is also known as approach crafting, while job crafting with a reactive motivation is known as avoidance crafting. Approach crafting refers to self–directed actions to obtain positive work aspects, whereas avoidance crafting refers to self–directed actions to avoid or avoid negative work aspects (Bruning & Campion, 2018; Zhang & Parker, 2019).

Work outcomes of job crafting

A meta–analysis of job crafting, and its outcomes found that it is linked to person–job fit, well–being, work engagement, job satisfaction, and work performance (Rudolph et al., 2017). More recent meta–analyses, (e.g. Lazazzara et al., 2020), nuance these positive outcomes to some extent. Job crafting appears to have especially favorable effects with approach crafting. Avoidance crafting appears to have no or a rather negative effect on individual performance. Reducing job demands deprives employees from the stimulating changes of their job and harms their performance. It could also indicate a broader avoidance motivation or withdrawal behavioral pattern, which could lead to neglect or mental abandonment of the work (Lazazzara et al., 2020). However, the research of Mäkikangas (2018) and later Petrou & Xanthopoulou (2021) suggest that concurrent avoidance and approach crafting ensures that the approach buffers the negative effects of avoidance crafting.

Job crafting among workers with disabilities

According to Wrzesniewski & Dutton (2001), practically anyone can craft his or her job, at least to some extent. Their research includes numerous examples of job crafting among people from diverse occupational groups, such as cooks, cleaners, and child supervisors. Over past years, job crafting research has provided findings on vulnerable workers, including low skilled workers (e.g. Fuller & Unwin, 2017), older employees (e.g. Kooij, Nijssen, Bal & Van Der Kruijssen, 2020), migrant workers (e.g. Arasli, Arici & Ilgen, 2019), temporary employees (e.g. Plomp, Tims, Khapova, Jansen & Bakker, 2019), and employees with disabilities (Brucker & Sundar, 2020; Macchitella et al., 2021; Sundar & Brucker, 2021).

However, workers with disabilities are less likely to craft their job than those without disabilities. Workers with both disabilities and higher educational levels were more likely to engage in job crafting, whereas those with mobility limitations were least likely to do so (Brucker & Sundar, 2020). This is unfortunate considering the challenges workers with disabilities experience in their work today. For example, research shows that workers with disability often lack the workplace accommodations and/or extra support they need in order to perform their job optimally (Van Laer, Verbruggen & Janssens, 2011). According to Baldridge and Veiga (2001, 2006), organizations may not provide accommodations because people with disabilities do not request them. Partly because they are worried about how others will perceive them and whether they will be stigmatized. Requesting assistance may make them appear less competent or capable, or it may invite labeling. Partly because they are afraid of not being able to reciprocate, or of tilting resource distribution inequitably

against coworkers. Partly due to a desire not to impose on others (for example, asking people to slow down for the sign language interpreter) (Baldridge & Veiga, 2001, 2006; Kulkarni & Lengnick–Hall, 2011; McLaughlin, Bell & Stringer, 2004). Workers with disabilities also score less well in terms of career development. Compared to people without disabilities, they start more often in low–skilled and thus low–paid jobs at entry level with low autonomy (Barnes & Mercer, 2005; Pagán & Malo, 2009), which may limit their ability to engage in job crafting. They may also have careers that have plateaued, in that they do not always reach administrative and professional positions that others without disabilities do. Further, they have fewer career opportunities, fewer opportunities for internal and external mobility, and fewer opportunities for continuing education and training (Kulkarni & Gopakumar, 2014). This sticky floor is viewed as an issue with both employee and employer–related contributors. Employers believe that employees with disabilities may feel comfortable in their jobs, reducing their desire to advance. People with disabilities may be discouraged from seeking employment because of new probationary periods and accessibility concerns. As a result, it is likely that people with disabilities do not signal their ability or desire for career advancement (Hernandez et al., 2008; Lustig & Strauser, 2003). Unfortunately, this may have a detrimental effect on their internal and external marketability (Arthur, Khapova & Richardson, 2017), which is often referred to as perceived employability in the work and organization literature (Vanhercke, De Cuyper, Peeters & De Witte, 2014). Assuming that workers are increasingly responsible for their own work and career development, perceived employability can be defined as one's perceived possibilities to obtain and maintain employment (De Vos & Van der Heijden, 2017). Earlier studies have shown a positive relationship between job crafting and employability (Brenninkmeijer & Hekkert–Koning, 2015; Tims, Bakker & Derks, 2012).

OBJECTIVE

In the present study, we introduce and examine the JOS app, a new tailored web–based job crafting intervention tool that aims to make job crafting more accessible to workers with disabilities and increase their engagement in job crafting behaviors. By doing so, we want to enable them to work on promoting their sustainable employability. The aim of this study was to test the effectiveness of the JOS app, with a pretest–posttest study design, to improve work related outcomes among worker with disabilities. Therefore, the following research hypotheses were developed (see Figure 1):

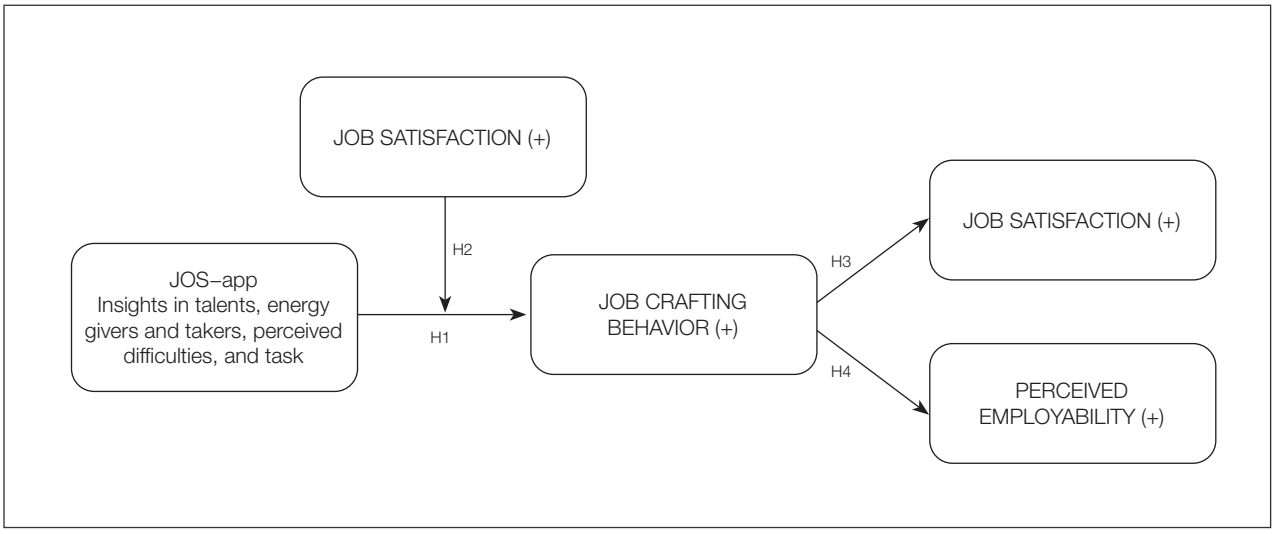
- H1: Using the JOS app, and thus gaining insights in own tasks, talents, energy givers and takers, and perceived difficulties in work, leads to more job crafting behavior among participants.
- H2: Job autonomy is a condition for effectiveness of the JOS app to stimulate job crafting behavior.
- H3: Participants experience higher job satisfaction after using the JOS app compared to their job satisfaction before the intervention.
- H4: Participants experience higher employability after using the JOS app compared to their employability before the intervention.

METHODS

Intervention

The JOS app, which is based on the job crafting theory of Wrzesniewski & Dutton (2001), has been developed as a self–guided web–based application that stimulates and facilitates job crafting through micro–interventions (i.e. without intensive contact with a trainer or coach, but through online communication technology) and tailored to people with disabilities. The JOS app consists of 8 steps, which includes brief job crafting exercises to reflect upon themselves (e.g. abilities, energy eaters and givers) and their work, the fit between those two, and to think about possible job crafting strategies to improve this fit. Each step starts with an introductory video, in which the character JOS tells the user what they need to know about the specific stage. During five–weeks users receive several invitations to complete all steps. Each step can be considered separately as a micro–intervention. After each step, users can choose to go immediately to the next step, although the app encourages them to take a break after each step. By accessing the JOS app from Google Chrome, participants can use the auto–translate feature in Chrome that automatically translates a web page from a foreign language into a native one. Using a mobile phone or tablet, speech to text programs can be used to fill in the answers in the JOS app (see Appendix).

Figure 1 – The study hypotheses



Participants

This study was carried out from April 2021 to December 2021. Study participants were enrolled by convenient sampling via various organizations working with people with disabilities (advocacy groups, sheltered workplaces, service providers, welfare organizations, sports associations, etc.), and those who responded first were the sample. The inclusion criteria for participants were: (1) 18–67 years old; (2) experienced a physical or mild mental/psychological condition which limited their work performance; (3) employed in a regular or sheltered or volunteer (unpaid) job; (4) absence of cognitive limitations that prevented them from providing informed consent. Interested individuals applied via mail and were then asked whether they experience a long–term illness, condition, or disability, and if so, to what extent they feel impeded in their daily activities as a result. These two questions were meant to assess as to whether the interested individual belonged to our intended target group. If so, they received an invitation to the survey a few days later.

Study design

A pre– and post–intervention study without control group was conducted. Therefore, we put this study as a pilot study to investigate the effectiveness of our job crafting intervention preliminarily. The ethics review board of the Odisee University approved the procedures before the start of the study. The survey began with a cover letter informing the participants about the study's content and goal, as well as asserting that responses would be kept confidential, and participation was voluntary. Before proceeding to the survey items, participants provided informed consent. Participants provided informed consent before moving on to the survey items. Participants completed a survey prior to the intervention (T1, pre–test) and 2 weeks after the intervention (T2, post–test). In between pre– and post–test, participants completed the JOS app steps during the 5 weeks of job crafting.

Measures

All data were collected using a web–based self–report survey at baseline (T1) and post–intervention (T2). The survey was created in Qualtrics® and included standardized questions. The questionnaire took 15 minutes or less to complete.

– *Job crafting behavior* was measured with the *Overarching Job Crafting Scale* of Vanbelle (2017), consisting of four items. Example items are: 'I make changes in my job to feel better', 'I change my job so it would better fit with who I am'. All responses were given on a five–point scale (1 = totally disagree, 5 = totally agree). Since contextual crafting behavior is missing from this scale, we added the following

item: 'I make my own changes in my environment so that I can function better in my job.' Job crafting behavior was measured by calculating an average score for the five items. Reliability is respected as Cronbach's α = .84

- *Job autonomy*. We used the subscale 'autonomy' of the *Work Design Questionnaire* of Morgeson & Humphrey (2006). The scale consisted of three items that were rated on a five–point Likert scale ranging from 1 (totally disagree) to 5 (totally agree), with Cronbach's α = .83. A sample item is 'I can decide how to do my work.' Autonomy was measured by calculating an average score for the three items.
- *Job satisfaction* was measured by calculating an average score for the four items of the *Work Domain Satisfaction Scale*, a multi–item scale of Blais and colleagues (Blais, Lachance, Forget, Richer & Dulude, 1991). Example items are: 'I am satisfied with my work', 'My work fits well with what I am good at.' Items were rated on a five–point Likert scale ranging from 1 (totally disagree) to 5 (totally agree). The Cronbach's α = .80
- *Employability*. Perceptions on internal and external employability were measured by calculating an average score of the four items from the scale of De Cuyper and De Witte (2008). Example items are: The items were: 'I could easily find another job at my current employer', 'I could easily find a better job with another employer'. Items were scored on a 5–point scale (1 = totally disagree, 5 = totally agree), with Cronbach's α = .74.
- *Insights in talents, energy givers and takers, perceived difficulties, and tasks*. For employees to know which job adaptations will be most beneficial, it is important that they gain insights in their tasks, talents, energy givers and takers, and perceived difficulties in their work. The exercises in the first 4 steps of the JOS app are designed to help users gain these insights. In the post survey, we asked participants to what extent the app contributed to a better understanding of their tasks, talents, energy givers and takers, and perceived difficulties in their work.

Statistical analysis

The collected data has been analyzed with the help of SPSS. Firstly, descriptive analysis (means and standard deviations) was conducted to reveal levels of participants' insights in talents, energy givers and takers, perceived difficulties, and tasks, and participants' job crafting behavior, job satisfaction, employability, and job autonomy. Secondly, correlation analysis evaluated the relation between insights in talents, energy givers and takers, perceived difficulties, and tasks, and job crafting behavior at T2, and between job crafting behavior and job satisfaction, and between job crafting behavior and employability. Thirdly, paired–samples t–tests were performed to examine whether the levels of job crafting behavior, job satisfaction, and employability at T2 differed from those at T1. Finally, data were analyzed with regression analyses to see the effect of job autonomy on job crafting behavior.

Validity

All items were translated in Dutch using the back–translation method. To ensure that the survey was comprehensible and readable for all study participants, including those with a mild intellectual disability, all items were re–examined and if necessary adapted or simplified by an organization working on multiple fronts to develop the talents of people with disabilities. The Likert scale used was also clarified visually using the *Thumbs–Up* scale. Finally, ten persons with a mild intellectual disability tested the modified survey.

RESULTS

Participants

In total, 45 workers with a disability participated in the study and answered the baseline questionnaire (T1) and completed the postintervention survey (T2). Demographic characteristics of participants are presented in Table 1.

Better understanding of themselves and their work

Based on the scores in Table 2, we could say that the JOS app has succeeded in giving participants insight into their tasks, talents, energy givers and takers, and perceived difficulties in their work.

Our research also shows a significant correlation (r = .40, p = .023) between 'insight into yourself and work situation' and 'job crafting behavior T2'. Participants who score higher

Table 1 – Demographic characteristics of participants

Participants	Total *n* (%) *n* = 45
Gender	
Female	26 (57.8%)
Male	18 (40.0%)
Other	1 (2.2%)
Age	
<45	32 (71.1%)
≥45	13 (28.9%)
Education	
No diploma	19 (42.2%)
Diploma of high school	8 (17.8%)
Diploma of higher education	18 (40.0%)
Disability	
Physical	38 (84.4%)
Mild cognitive	7 (15.6%)
Work	
Regular employment (paid)	18 (40.0%)
Sheltered employment (paid)	15 (33.3%)
Volunteer work (unpaid)	12 (26.7%)

Table 2 – Scores on gaining insights in tasks, abilities, talents, preferences, and needs (n = 45)

	Through the JOS app, I have gained insight into my…				
	Tasks	Talents	Energy givers	Energy takers	Difficulties
Mean	3.8/5	3.8/5	3.8/5	3.8/5	3.7/5
Median	4.0/5	4.0/5	4.0/5	4.0/5	4.0/5
Standard Deviation	.85	.85	.85	.79	.91

on the questions that probe 'insight into yourself and the work situation', also score higher on 'job crafting behavior' in the post–test.

Evolution of outcome variables at baseline, and post–intervention

Table 3 shows the means and standard deviations of the outcome variables at baseline (T1), and post–intervention (T2). The means of work job crafting behavior (total) increased over time. Job satisfaction and employability did not change significantly.

Effect on job crafting behaviors

The job crafting intervention showed a significantly positive effect on the evolution of job crafting behaviors before and after (Table 3). The degree to which participants progressed in job crafting behaviors differed depending on whether they already exhibited these behaviors before using the JOS app and the degree to which they experienced job autonomy in their work (see Figure 2). The greatest progress in job crafting behavior (+.68 points) is seen among participants who score high on job autonomy (≥3/5) and low on job crafting behavior (<3/5) at T1, followed by participants who score high on job autonomy (≥3/5) and high on job crafting behavior at T1 (≥3/5) (+.42 points). However, also participants scoring low on job autonomy (<3/5) but low on job crafting behavior at T1 exhibited more job crafting behavior at T2 (+.40 points). The other participants – low score on autonomy and high on job crafting behavior at T1 – deteriorate slightly (–.08 point).

Effect on job satisfaction and employability

The pretest shows a positively significant relationship between job crafting behavior and job satisfaction (r = .42, p<.001) and a slightly weaker positively significant relationship between job crafting behavior and employability (r = .21, p = .042) (see Table 4).

At T2, the correlations between the variables generally increased (r = .52, p<.001; r = .33 and p<.029, respectively) (see Table 5). However, between the pre– and post–measurement, there is almost no change in the scores given by participants on job satisfaction and perceived employability.

CONCLUSIONS

The aim of this study was to test the effectiveness of the JOS app, a tailored web–based job crafting intervention tool for workers with disabilities.

Our research shows that JOS app can encourage people with disabilities to engage in more job crafting behavior. The mean score for job crafting behavior increased significantly

Table 3 – Evolution of outcome variables at baseline, and post–intervention follow–up (n = 45)

	T1		T2		T2–T1	*p* value
	Mean	*SD*	*Mean*	*SD*		
Job crafting behavior	3.29	.86	3.65	.94	.36	p<.001
Job satisfaction	3.30	1.24	3.38	1.44	.08	p = .741
Employability	3.10	1.06	3.07	.95	–.03	p = .445

Figure 2 – Evolution of job crafting behavior, considering autonomy T1 and job crafting behavior T1 (N = 45)

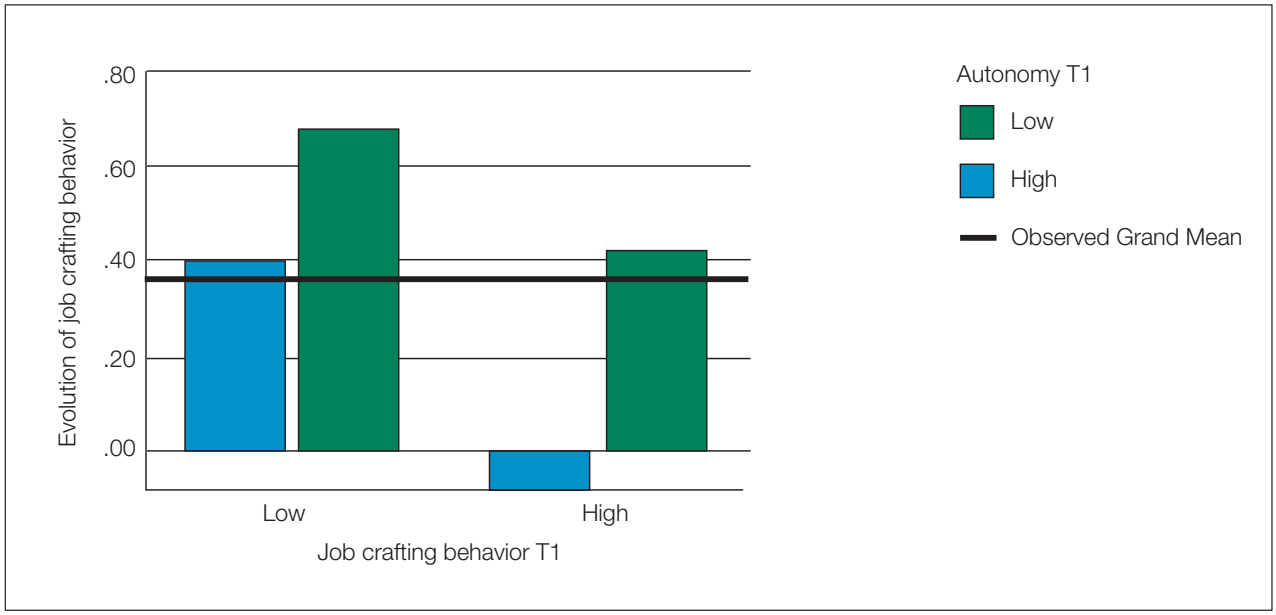


Table 4 – Pearson correlation coefficient between job crafting behavior T1 and employability and job satisfaction T1

Pre–test (*N* = 45)	Employability T1	Job satisfaction T1
Job crafting behavior T1	.21*	.42**

* $p<.05$, ** $p<.001$

Table 5 – Pearson correlation coefficient between job crafting behavior T2 and employability and job satisfaction T2

Pre–test (*N* = 45)	Employability T2	Job satisfaction T2
Job crafting behavior T2	.33*	.52**

* $p<.05$, ** $p<.001$

between the pre– and post–measurement. Wrzesniewski & Dutton (2001) state that practically anyone can craft his or her job, at least to some extent. This also applies to people with disabilities, as was recently shown in several studies (Brucker & Sundar, 2020; Macchitella et al., 2021; Sundar & Brucker, 2021). In our research we see that especially participants who were not or less engaged in job crafting beforehand, improved the most in terms of job crafting behavior. Particularly when they feel that they experience autonomy in their work. This is in line with the meta–analyses conducted by Rudolph et al. (2017), which suggests that job crafting behavior is positively related to job autonomy. Nevertheless, we see that even participants who experience little job autonomy exhibit more job crafting behaviors if they were little or not engaged in job crafting beforehand. Despite their limited job autonomy, they still manage to improve something about their work. This is consistent with Wrzesniewski & Dutton's (2001) assumption that every job has some degrees of freedom to be customized by employees for it to better fit their talents, abilities, preferences, and needs. Or, in the words of Frederick and VanderWeele (2020): "Although jobs come with instructions on what to do, there are still degrees of freedom during the workday. In other words, how an employee allocates their time and energy to do the job is not wholly specified. It is in these degrees of freedom that job crafting as a behavior lives" (p. 5).

Using the JOS app has led to more job crafting behavior among participants, but not (yet) to more job satisfaction and/or more perceived employability. Our research shows that the scores on both job satisfaction and perceived employability remained virtually unchanged. These results are not in line with other research, which did find a positive relationship between a job crafting intervention and higher job satisfaction and employability (Rudolph et al., 2017). One possible explanation for these results is that the post measurement was conducted too soon after the intervention, so the positive effect was not yet experienced by the participant. For example, participants may have become more aware of their employability by the JOS app, without having had the time or opportunity to make actual changes at their jobs at the time of the post measurement. This result is consistent with recent claims that proactive behavior may not have any effects at all, or even negative effects, in the short term but positive effects over the long term. The benefits of proactive behavior might take longer to manifest (Cangiano, Parker & Ouyang, 2021; Giunchi, Vonthron & Ghislieri, 2019).

Limitations

This study has some limitations. First, this study was conducted during the COVID–19 pandemic. Given the level of disruption to working life most people were facing as a result of COVID–19, it is likely that many employees are job crafting independently – whether or not they are doing this consciously. Measures taken to prevent the spread of covid–19, such as working remotely and social distancing, could also limit the opportunities to engage in job crafting. Second, job crafting behavior was measured by the *Overarching Job Crafting Scale* of Vanbelle (2017). This scale measures job crafting in a more general way, which enables us to capture the whole range of job crafting. The disadvantage, however, is that this scale offers too little insight into actual job crafting behavior. Due to privacy reasons, we do not have access to the information that participants have submitted in the JOS–app. Therefor we do not know in what way – avoidance of approach – the participants have modified their job. As indicated above, approach crafting has beneficial effects on job satisfaction, while avoidance crafting can have no or a negative effect on job satisfaction (Lazazzara et al., 2020). To have future insight into how participants do their job crafting without violating their privacy, we will use a different scale to measure job crafting behavior. The *Approach–Avoidance Job Crafting Scale* of Lopper, Horstmann and Hoppe (2020) seems to us an interesting alternative. A third limitation is that participants are a very heterogeneous group regarding their disability and the sample is too small for subgroup analysis. Further research should determine whether the intervention is useful for each type of disability. Finally, a control group is missing, which is a threat to the internal validity.

Conflict of interest: the Authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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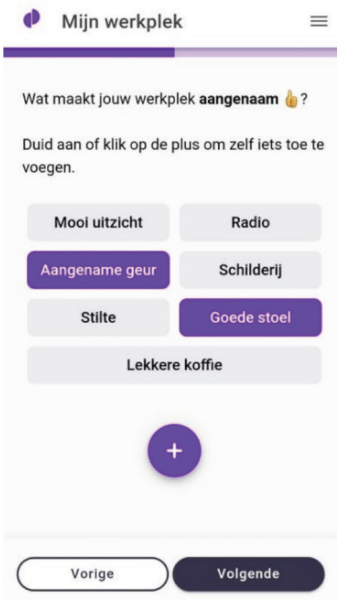
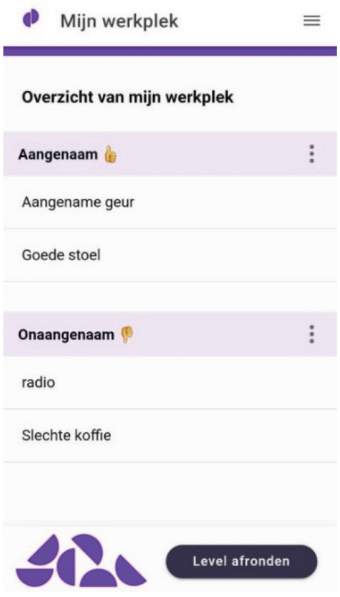
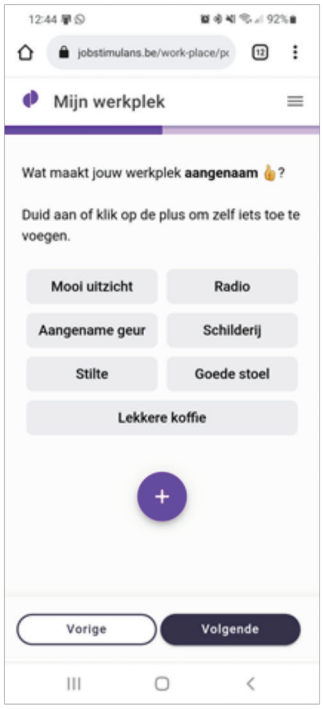
APPENDIX

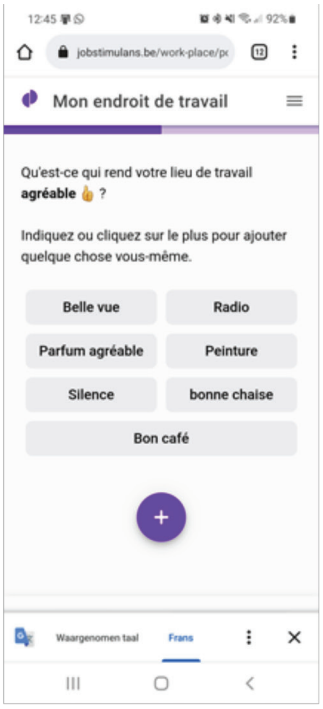
– The JOS app, level 'mijn werkplek' (Eng: emy workplace)

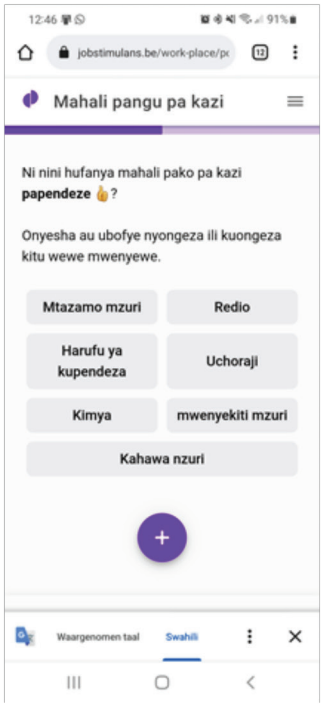


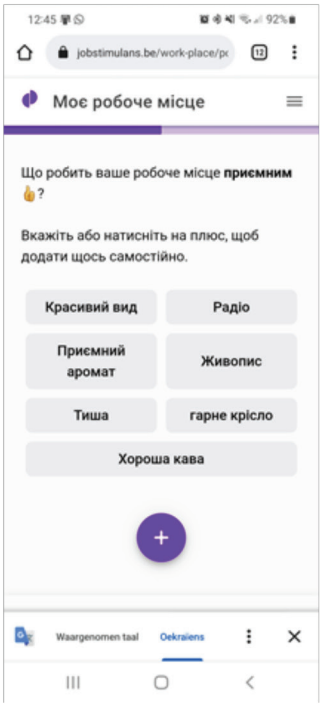


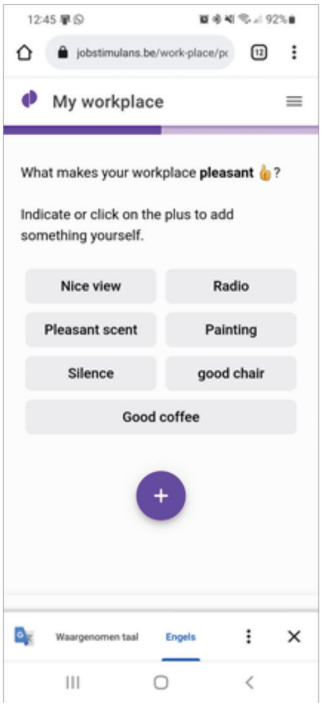
– The JOS app automatically translated by Google Chrome into English, French, Arabic, Kurdish and Swahili











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The assessment of drivers' acceptance of automated vehicles in Italy: Development and initial validation of a short self-report measure

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ABSTRACT. I veicoli a guida autonoma hanno un enorme potenziale di modifica della viabilità; pertanto, la valutazione dei fattori che possono influenzare i guidatori nel loro utilizzo riveste un ruolo centrale. Lo scopo di questo studio consisteva nello sviluppo di una misura finalizzata alla valutazione dei seguenti aspetti: (a) disposizione positiva nei confronti della tecnologia (*Technology Optimism Scale; TOS*); (b) disposizione positiva nei confronti dei veicoli a guida autonoma (*Perception of Automated Vehicles; PAV*) e (c) attitudine nei confronti della mobilità sostenibile (*Sustainable Mobility Attitudes; SMA*). Il campione reclutato per lo studio ha incluso 730 soggetti adulti italiani (61% di sesso femminile; età media = 36.39 anni). Sono state condotte analisi bivariate e multivariate, oltre all'utilizzo della exploratory graph analysis al fine di esaminare le proprietà di misurazione delle scale. TOS, PAV e SMA hanno mostrato adeguata affidabilità e relazioni significative con specifiche variabili demografiche e personologiche. Nel complesso, i risultati dello studio suggeriscono la possibilità di utilizzare questi strumenti nell'ambito della ricerca sui veicoli a guida autonoma.

SUMMARY. Autonomous vehicles (AVs) have the potential to transform mobility. Exploring factors influencing driver' acceptance of AVs has become crucial. We aimed at developing a short measure assessing: (a) positive dispositions towards technology (Technology Optimism Scale; TOS); (b) positive dispositions towards automated vehicles (Perception of Automated Vehicles; PAV); and (c) sustainable mobility attitudes (Sustainable Mobility Attitudes; SMA) in Italy. A sample of 730 Italian community-dwelling adult participants (mean age = 36.39 years; 61.1% female), was administered the TOS, PAV, and SMA items. Bivariate and multivariate item analyses were carried out; moreover, exploratory graph analysis was conducted to examine the structure of the measure. Internal consistency estimates of the TOS, PAV and SMA total scores were computed; associations between TOS, PAV, and SMA total scores, and demographic variables and personality traits, respectively, were assessed. The TOS, PAV, and SMA total scores were provided with adequate reliability and showed meaningful relationships with selected demographic variable and personality traits. Our findings may represent a useful contribution to the available literature on AVs providing researchers a short measure to assess different aspects contributing to the perception of AVs, at least among Italian community-dwelling participants.

Keywords: *Autonomous vehicles, Driver' acceptance, Perception of Automated Vehicles, Technology Optimism Scale, Sustainable Mobility Attitudes*

INTRODUCTION

Autonomous vehicles (AVs) are vehicles that could monitor the driving environment and work in automated driving (Society of Automotive Engineers, 2018). AVs have the potential to transform mobility and improve efficiency on roads, while reducing traffic accidents and minimizing environmental impact (e.g., Ryan, 2020; Stone, Santoni de Sio & Vermaas, 2020). Despite these positive factors, it should be observed that these benefits will be accessible depending upon the acceptance of AVs. Indeed, negative publicity around AVs (e.g., because of the accidents they have caused) has been spread (e.g., Ryan, 2020), and public skepticism over safety represent key barriers to AVs acceptance (e.g., Zhang et al., 2019).

Notably, Tennant and colleagues (2019) carried out an extensive review on the perception of AVs and performed a large survey (N = 11,827) across 11 European countries examining attitudes towards AVs. Confirming and extending previous European data (European Commission, 2017), Tennant, Stares and Howard (2019) showed that more respondents were uncomfortable with the prospect of AVs. Against this background, exploring factors influencing driver' acceptance of AVs has become crucial (e.g., Liu, Yang & Zu, 2019). Indeed, the efforts to understand public acceptance of AVs are still relatively limited and its psychological correlates remain largely unknown (e.g., Xu et al., 2018).

Up to now, different studies examined the role of demographic variable and the perception of AVs (e.g., Penmetsa, Adanu, Wood, Wang & Jones, 2019). These research findings suggested that public acceptance of AVs may vary according to geographic location and gender (KPMG, 2013), but results have been quite debated. For instance, some results suggested female to be more interested in AVs than male participants (e.g., KPMG, 2013), and other studies showed male to manifest greater acceptance to AVs than female participants (e.g., Hulse, Xia & Galea, 2018).

Although results are still controversial (e.g., Hartwich, Witzlack, Beggiato & Krems, 2019; Nielsen & Haustein, 2018), selected socio-economic characteristics (e.g., Becker & Axhausen, 2017) were found to be associated with the willingness to use AVs. For example, Nikitas, Vitel and Cotet (2021) carried out an international study and found that respondents studying or working in the information technology and financial industries thought that automation of the transport industry will follow the path of other automated industries, suggesting that job may play a role in the perception of the changes related to the mobility. Similarly, Hudson, Orviska and Hunady (2019) found that individuals' degree of comfort with AVs decreased if they were unemployed or retired. Notably, educational level (e.g., Hudson et al., 2019), and dispositions towards technology (e.g., Tennant et al., 2019), have been found to influence the willingness to use AVs.

Up to now, few studies examined the associations between trust in AVs and driver's personality traits (Li et al., 2020). For instance, Kyriakidis, Happee and de Winter (2015) found that participants scoring higher on neuroticism were slightly less comfortable about AVs data transmitting, while Charness, Yoon, Souders, Stothart and Yehnert (2018) found that emotional stability (i.e., low neuroticism) and openness to experience were positive predictors of eagerness to adopt AVs.

One of the limitations of the available literature on the acceptance of AVs is related to the variability of the measures used (e.g., Adell, Varhelyi, & Nilsson, 2014; Zoellick, Kuhlmey, Schenk, Schindel & Blüher, 2019). Moreover, a recent study (Kacperski, Kutzner & Vogel, 2021) conducted in a sample of 529 participants from France, Germany, Italy and the United Kingdom showed that responses varied substantially between countries, with the most positive views being from Italy. As a whole, Kacperski and colleagues (2021) provided insight into the respondents' general reticence about their intention to use AVs, while suggesting future research to focus on larger samples to study between-country differences to provide specific insights into AVs acceptance, to make them accessible for a variety of populations and their cultural demands. From this perspective, the availability of a short measure to examine the acceptance of AVs in Italy would allow for future studies to recruit larger samples of Italian participants.

The present study

Against this background, we aimed at developing a short measure providing 1) a scale to assess positive dispositions towards technology (i.e., T*echnology Optimism Scale; TOS*); 2) a scale measuring positive dispositions towards automated vehicles (*Perception of Automated Vehicles; PAV*), and 3) a scale assessing sustainable mobility attitudes (*Sustainable Mobility*

Attitudes; SMA). Thus, we designed the preset study as the first attempt at providing item validity, internal consistency reliability estimates, and dimensionality assessment of this short new measure.

Furthermore, preliminary validity data with respect to demographic characteristics and personality traits were considered. Indeed, previous data showed the relevance of these variables for the perception of AVs, dispositions towards technology and sustainable attitudes. For instance, personality traits were found to be associated with these constructs (e.g., Weigl, Nees, Eisele & Riener, 2022), and Barnett, Pearson, Pearson and Kellermanns (2015) found that while conscientiousness was positively associated with perceived and actual use of technology, neuroticism showed negative relationships with these variables.

Initial bivariate (i.e., item-total *r* coefficients corrected for part-whole overlap) and multivariate item analyses (i.e., item cluster analysis; Revelle, 1978) were conducted. Relying on factor analysis for dimensionality and latent structure assessment of the TOS, PAV, and SMA items may represent a sub-optimal choice. Indeed, scale item were likely to represent cause indicators rather than effect indicators (i.e., observable variables which reflects the effect of the latent construct; Bollen, 1989). Indeed, variation in the opinions expressed on the technology optimism scales are likely to produce a variation in the overall level of technological optimism; rather, it seems unlikely that participant's answers to technological optimism items reflect different manifestations of a latent variable. In a sense, it is a situation similar to socio-economic status assessment; a variation in observable indicators (e.g., income, home property, education level, etc.) produces a variation the socio-economic status (i.e., the construct) level, whereas manipulating the values of socio-economic status does not change participant's income, home properties or educational level (i.e., the observable indicators).

Recent psychometric approaches may provide useful alternatives to factor analysis when the existence of latent constructs causing the variation in the observable indicators is called into question (Golino & Epskamp, 2017). Exploratory graph analysis (EGA) is a recently developed technique from the field of network psychometrics (Golino & Epskamp, 2017); in this approach, items are considered to directly affect each other rather than being caused by an unobserved latent construct; accordingly, items that share strong connections and are in close proximity to each other can form any number of communities (Christensen, Gross, Golino, Silvia & Kwapil, 2019; Fried & Cramer, 2017).

After examining the structure of TOS, PAV and SMA items, we focused on their reliability and validity in order to provide support to the hypothesis that they represent useful assessment instruments. To this aim, we firstly assessed the reliability of the TOS, PAV, and SMA total scores, which were expected to be provided with adequate internal consistency estimates. After that, we evaluated their association with demographic variables (i.e., gender, educational level, civil status, job) which showed to be useful in assessing public acceptance of AVs (e.g., Hohenberger, Spörrle & Welpe, 2016). Specifically, we hypothesized to observe higher TOS scores for male participants (e.g., Kacperski et al., 2021; Tennant et al., 2019), as well higher score on the PAV scales for participants with a higher educational level (e.g., Bansal, Kockelman & Singh, 2016). Based on previous data on the relationships between employment status and AVs perception (e.g., Hudson et al., 2019), a possible effect of job on PAV scores was expected. Because adoption of novel technology may be influenced by the characteristics of the adopter (e.g., Hegner, Beldad & Brunswick, 2019), we examined the associations between personality and TOS, PAV, and SMA total scores. Based on previous data on the relationships between personality traits and AVs perception (Kacperski et al., 2021; Kyriakidis et al., 2015), we hypothesized to observe significant associations between PAV total score and openness to experience and neuroticism scales, respectively. Finally, we hypothesized a positive association between TOS total score and conscientiousness, and a negative relationship between TOS total score and neuroticism (e.g., Barnett et al., 2015).

METHOD

Participants

The sample was composed of 730 Italian community-dwelling adult participants, with a mean age of 36.39 years (*SD* = 15.65 years; age range: 18 years-82 years); 4 (.5%) participants refused to disclose their age. In our sample 446 (61.1%) participants were female and 276 (37.9%) participants were male, 4 (.5%) participants identified their gender outside the gender binary, whereas 4 (.5%) participants refused to disclose their gender. Four thousand five hundred fifteen

(56.8%) participants were unmarried, 282 (38.6%) were married, 24 (3.3%) participants were divorced, and 6 (.8%) participants were widow/-er; 3 (.4%) participants refused to disclose their civil status. Twenty-six (3.6%) participants had junior high school degree, 301 (41.2%) participants had high school degree, 354 (48.5%) participants had university degree, and 48 (6.6%) participants had doctoral degree; one (.1%) participant refused to disclose his/her educational level. Eighteen (2.5%) participants were unemployed, 26 (3.6%) participants were retired, whereas 686 (94.0%) were active community members; 6 (.8%) participants refused to report their job. To be included in the sample, participants had to have been in possession of a car driver's license; on average participants held driving license from 17.21 years (*SD* = 15.12 years).

Procedures

Participants completed the study online using Online Surveys Jisc, an online survey tool designed for academic research (https://www.onlinesurveys.ac.uk/); participants volunteered to take part in the study receiving no economic incentive or academic credit for their participation. To be included in the sample, participants had to document that they were of adult age (i.e., 18 years of age or older), been in possession of a car driver's license, and to agree to online written informed consent in which the study was extensively described. The TOS, PAV and SMA items were randomly included in a single questionnaire on "Attitudes towards technology and environment".

Measure translation procedure

The TOS, PAV and SMA items were independently translated into Italian by two psychologists who were fluent in both English and Italian languages. After reaching a first consensus, an English mother-tongue professional translator translated the Italian version back into English, and this English back-translation (e.g., van de Vijver & Hambleton, 1996) was compared with the original English version of the items. If the latest version differed from the English original, the translators came to an agreement on the definitive Italian translation. The final TOS, PAV and SMA items are provided in the Supplementary material.

Measures

- *Technological Optimism Scale* (*TOS*; see also Tennant et al., 2019). The TOS is a 7-item measure assessing participants' general views on technology; items are rated on a 5-point Likert scale ranging from *1* (Strongly disagree) to *5* (Strongly agree). Items were summed and averaged to yield the TOS total score, the higher the TOS total score, the higher the driver's trust in technology. Previous data suggested the usefulness of the TOS scale in assessing driver's dispositions towards technology (Tennant et al., 2019).
- *Perception of Automated Vehicles Scale* (*PAV*; see also Tennant et al., 2019). The PAV is a 12-item scale purportedly assessing driver's positive disposition towards automated vehicles. In the present study, each PAV item was rated on a 5-point Likert scale ranging from *1* (Strongly disagree) to *5* (Strongly agree). Items were summed and averaged to yield the PAV total score, the higher the PAV total score, the higher the driver's positive disposition towards automated vehicles. Previous data suggested the usefulness of the PAV scale in assessing driver's dispositions towards technology (Tennant et al., 2019).
- *Sustainable Mobility Attitudes* (*SMA*; see also Kaiser & Wilson, 2000). The SMA is a three-item measure of driver's sensitivity to ecological considerations in mobility planning. In the present study, each SMA item was rated on a 5-point Likert scale ranging from *1* (Strongly disagree) to *5* (Strongly agree). Items were summed and averaged to yield the SMA total score, the higher the SMA total score, the higher the driver's sensitivity to sustainable mobility considerations. The SMA items were selected from the *General Ecological Behavior Scale*, which showed to be provided with adequate psychometric properties (Kaiser & Wilson, 2000).
- *Big Five Inventory* (*BFI*; John & Srivastava, 1999). The BFI consists of 44 items which are rated on a five-point Likert scale from *1* (disagree a lot) to *5* (agree a lot). The BFI items are assigned to five scales measuring Extraversion (8 items), Agreeableness (9 items), Conscientiousness (9 items), Neuroticism (8 items), and Openness to experience (10 items). The BFI showed adequate psychometric properties also in its Italian translation (Fossati, Borroni, Marchione & Maffei, 2011).

Data analysis

Item-total correlations corrected for part-whole overlap ($r_{i\text{-}t}$) between each item and the total score of the scale to which the item was assigned were computed for each item scale. Multivariate item analyses were carried out relying on the Item Cluster Analysis (ICLUST; Revelle, 1979) algorithm, which allows to hierarchically cluster items to form composite scales. ICLUST is meant to do item cluster analysis using a hierarchical clustering algorithm specifically asking questions about the reliability of the clusters (Revelle, 1979); clusters are combined if coefficients α (average slip-half reliability) and β (minimum split-half reliability) increase in the new cluster. Cluster fit and pattern fit indices were used as cluster fit statistics (Revelle, 1979).

In the present study, we relied on exploratory graph analysis (EGA; Golino & Epskamp, 2017) to assess whether three dimensions could be identified for the TOS, PAV, and SMA items. EGA is a dimensionality assessment method which produces a visual guide (i.e., network plot) that indicates the number of dimensions to retain (Golino & Epskamp, 2017). EGA combines the Gaussian graphical model (Lauritzen, 1996), with the Walktrap algorithm (Pons & Latapy, 2006) for community detection on weighted networks to assess the dimensionality. In EGA models, nodes (i.e., circles) represent items and edges (i.e., lines) represent associations between the nodes. The EGA approach currently uses two network estimation methods (for a review, see Golino et al., 2020), namely, graphical least absolute shrinkage and selection operator (GLASSO; Friedman, Hastie & Tibshirani, 2008) and triangulated maximally filtered graph (TMFG; Previde Massara, Di Matteo & Aste, 2016). In the present study, in line with the results of Golino and colleagues' (2021) simulation study, we relied on Von Neumman Entropy (EFI.vn) to compare the results of graphical least absolute shrinkage and selection operator EGA (EGA_{GLASSO}) and triangulated maximally filtered graph EGA (EGA_{TMFG}); specifically, we selected the model with the lowest TEFI.vn (Golino et al., 2021). Moreover, to estimate the stability of dimensions identified by EGA, we relied on Bootstrap Exploratory Graph Analysis (bootEGA; Christensen & Golino, 2021), which allows to evaluate the stability of EGA results across bootstrapped EGA results. In the present study, we relied on the non-parametric bootEGA procedure that is implemented by resampling with a replacement from the empirical dataset; in particular, we relied on 1,000 bootstrap samples. Bootstrap EGA results allowed us to estimate the number of times each item was estimated to belong to the same dimension.

Although their usefulness is controversial (Hallquist, Wright & Molenaar, 2021), in line with previous network applications (e.g., Epskamp, Borsboom & Fried, 2018), we relied on centrality measures to assess the importance of individual nodes in the network. In particular, we examined three nodal centrality measures: strength, closeness, and betweenness (Epskamp et al., 2018). The strength of a node is defined as the sum of its edge weights (i.e., partial correlations) to other nodes; closeness is the sum of the shortest path lengths between a specific node and all other nodes; finally, betweenness quantifies how often the shortest paths among all nodes traverse a given node (e.g., Hallquist et al., 2021).

Cronbach's α coefficient and mean inter-item correlation (MIC) coefficient were used to evaluate the internal consistency reliability of the scales (Clark & Watson, 1995). Pearson *r* coefficient was used to assess the relationships between continuous variables.

RESULTS AND DISCUSSION

Descriptive statistics and item-total correlations corrected for part-whole overlap for the TOS, PAV, and SMA items are summarized in Table 1, Table 2, and Table 3, respectively. All $r_{i\text{-}t}$ coefficient values were suggestive of adequate discriminatory power for all items of the three scales. Accordingly, all items were retained for further analyses.

When ICLUST was used to formally assess whether the groups of TOS, PAV, and SMA items could be considered as fairly homogenous clusters, a single cluster solution was identified for TOS (cluster fit = .70; pattern fit = .97), PAV (cluster fit = .78; pattern fit = .97), and SMA (cluster fit = .70; pattern fit = .99) items, respectively. The rooted dendritic structure of the TOS, PAV, and SMA items are displayed in Figure 1, Figure 2, and Figure 3, respectively. These finding suggested that each set of items represented a homogeneous system of observable indicators purportedly assessing driver's technological optimism (i.e., TOS scale score), propensity towards automated vehicles (i.e., PAV scale score), and sensitivity to sustainable mobility (i.e., SMA scale score), respectively.

– *Exploratory Graph Analysis*. When the TEFI.vn index was used to compare different dimensionality structures between GLASSO and TMFG EGA methods (Golino et al.,

Table 1 – Technological Optimism Scale item analyses: descriptive statistics and bivariate item-total correlations corrected for part-whole overlap in Italian community-dwelling adult participants (N = 730)

Technological Optimism Scale items	*M*	*SD*	$r_{i\text{-}t}$
TECH1	2.57	1.09	.42
TECH2	3.89	1.01	.44
TECH3	3.56	.92	.45
TECH4	3.69	1.01	.50
TECH5	3.02	.91	.52
TECH6	3.06	1.10	.64
TECH7	2.85	1.11	.45

Note. $r_{i\text{-}t}$: Item-total *r* coefficient corrected for part-whole overlap.

Table 2 – Perception of Automated Vehicles Scale item analyses: descriptive statistics and bivariate item-total correlations corrected for part-whole overlap in Italian community-dwelling adult participants (N = 730)

Perception of Automated Vehicles Scale items	*M*	*SD*	$r_{i\text{-}t}$
PAV1	3.19	.97	.63
PAV2	2.48	1.02	.64
PAV3	2.34	.85	.36
PAV4	2.19	.92	.51
PAV5	3.57	.90	.42
PAV6	2.62	.95	.43
PAV7	3.12	.98	.52
PAV8	2.17	1.19	.34
PAV9	2.27	.98	.67
PAV10	3.07	1.22	.54
PAV11	2.30	1.00	.66
PAV12	3.05	1.04	.59

Note. $r_{i\text{-}t}$: Item-total *r* coefficient corrected for part-whole overlap.

Table 3 – Sustainable Mobility Attitudes Scale item analyses: descriptive statistics and bivariate item-total correlations corrected for part-whole overlap in Italian community-dwelling adult participants (N = 730)

Sustainable Mobility Attitudes items	*M*	*SD*	$r_{i\text{-}t}$
SMA1	2.30	1.25	.38
SMA2	2.48	1.23	.58
SMA3	2.92	1.48	.53

Note. $r_{i\text{-}t}$: Item-total *r* coefficient corrected for part-whole overlap.

Figure 1 – Rooted dendritic structure of the Technological Optimism Scale items (N = 730)

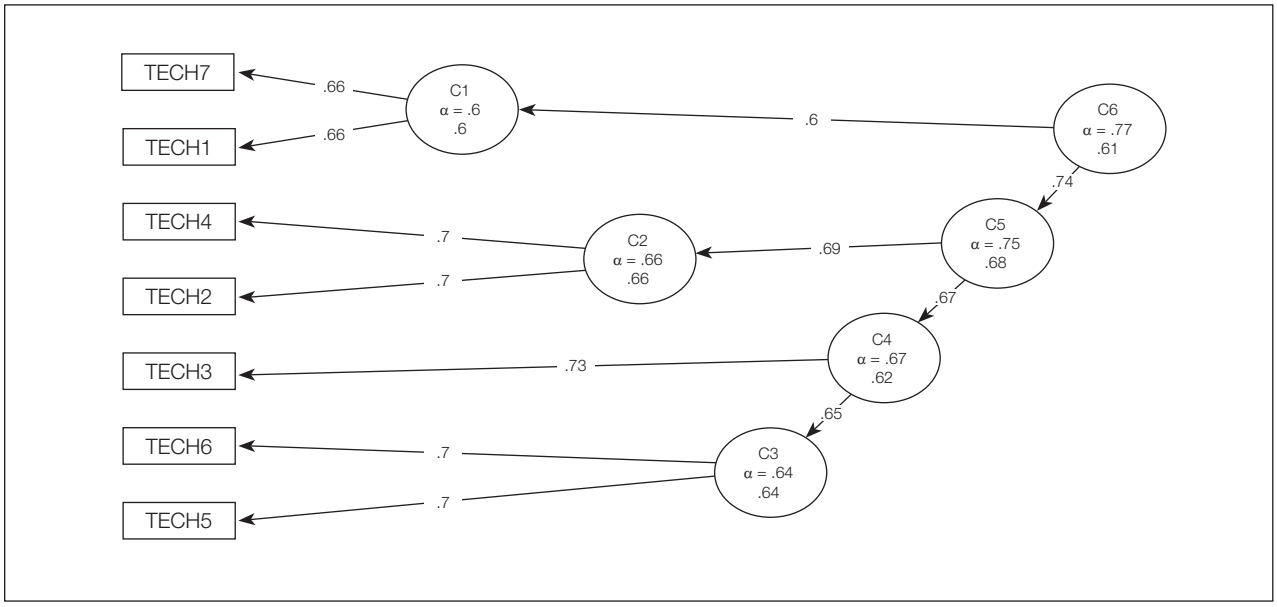


Figure 2 – Rooted dendritic structure of the Perception of Automated Vehicles items (N = 730)

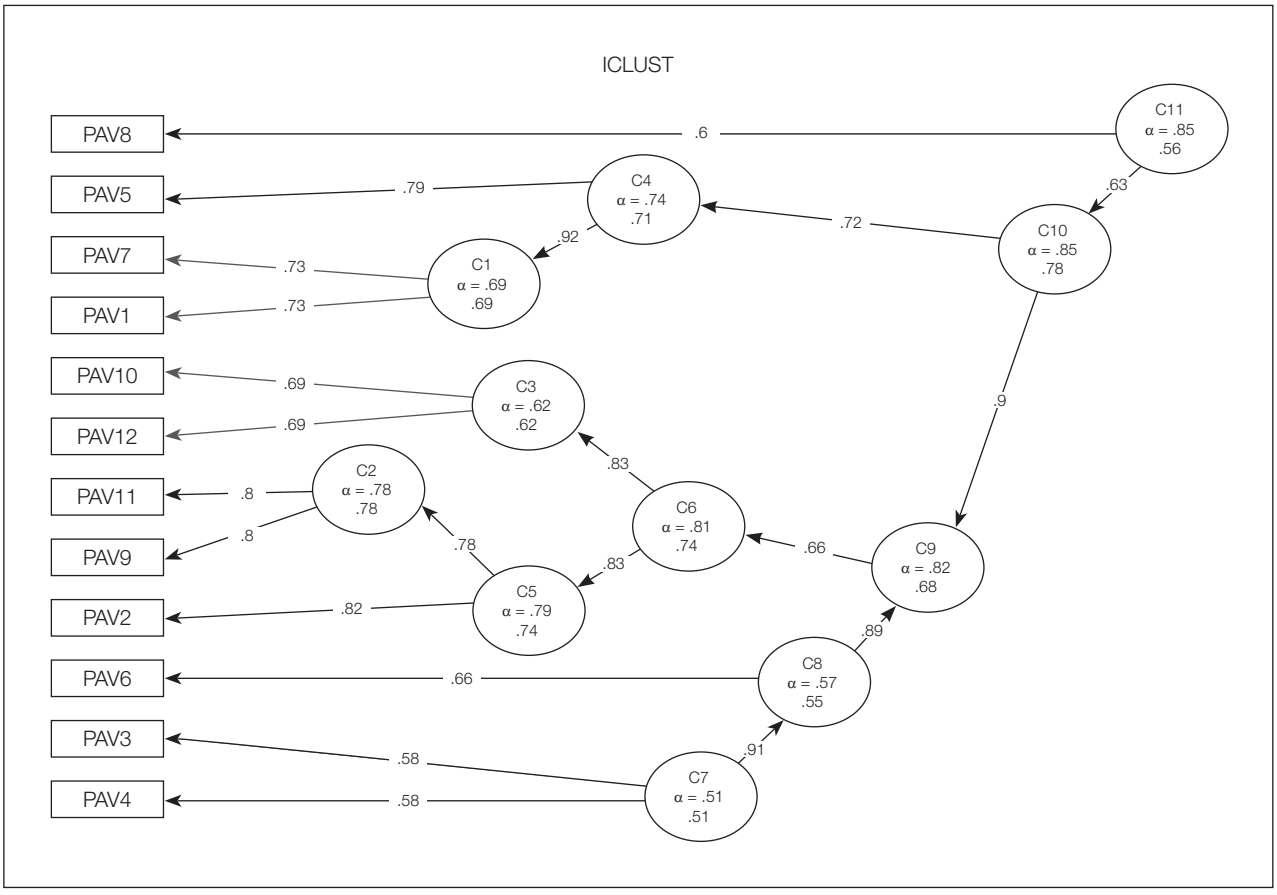
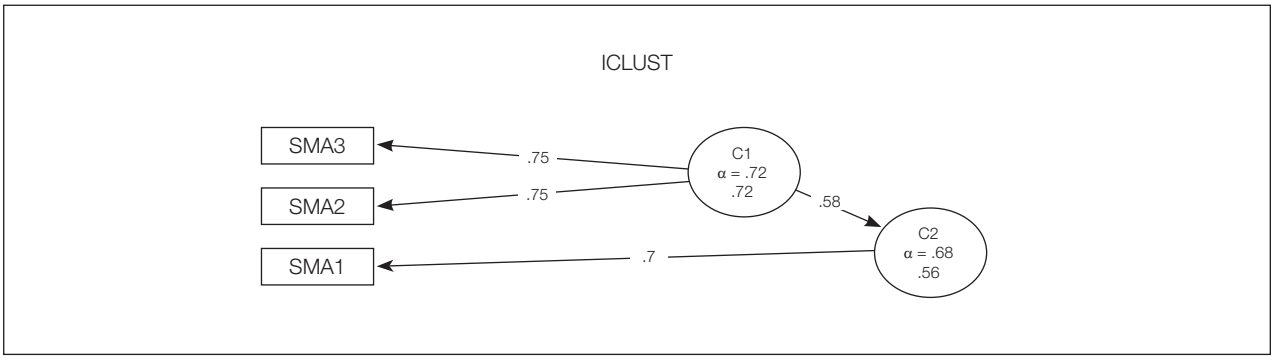


Figure 3 – Rooted dendritic structure of the Sustainable Mobility Attitudes items (N = 730)



2021), the structure estimated via EGA_{GLASSO} suggested three dimensions and presented the lowest TEFI.vn value (−21.11). Rather, the value of the TEFI.vn obtained with EGA_{TMFG} was higher (−20.21), and suggested to retain three dimensions. According to TEFI.vn index value, the EGA_{GLASSO} three-dimensions model was retained as best fitting model. This finding was consistent with our expectations, while confirming and extending bivariate $r_{i\text{-}t}$ analysis findings and ICLUST multivariate item analysis results.

Bootstrap EGA was used to estimate and evaluate the stability of dimensions identified by EGA_{GLASSO}; specifically, we carried out 1,000 non-parametric bootstrap (i.e., sampling with replacement) iterations. According to bootstrap EGA results, 3 dimensions were highly stable, median across the replica = 3, *SE* = .50, and 95% confidence intervals = 2.00, 3.99. The distribution of the proportion of times that a certain number of dimensions was replicated, confirms that 3 dimensions were the most stable dimensional organization of the data, being replicated 728 times (a unidimensional solution was found one time, four dimensions were replicated 248 times, five dimensions were replicated 23 times).

Figure 4 represents the EGA_{GLASSO} network, whereas Figure 5 provides a graphical summary the number of times each item was estimated in the same dimension according to bootstrap EGA_{GLASSO} results. The importance of individual nodes in the network was assessed by computing node centrality measures (Epskamp et al., 2018; Opsahl, Agneessens, & Skvoretz, 2010); the results of the visual analysis of centrality are displayed in Figure 6. As to the structure of the measure, EGA results supported the three-cluster model as the best-fitting solution, thus suggesting that the item pool that was administered in our survey could be safely assigned on the expected scales (i.e., TOS, PAV, and SMA scales).

– *Reliability and validity*. Based on univariate and multivariate item analysis, as well as on EGA_{GLASSO} results, we computed mean scores for the TOS, PAV, and SMA scale (Kaiser & Wilson, 2000; Tennant et al., 2019). Descriptive statistics, MIC and Cronbach's α values, as well as distribution percentiles, and scale inter-correlations for the TOS, PAV, and SMA scale scores are summarized in Table 4. As it can be observed, MIC items suggested adequate internal consistency for all scales (Clark & Watson, 1995), although the SMA scale showed a Cronbach's alpha coefficient value slightly lower than .70 (Nunnally & Bernstein, 1994).

When the TOS, PAV, and SMA scale mean scores were formally compared using repeated measure ANOVA, the Mauchly's sphericity test was highly significant, $W = .68$, $\chi^2\ (2) = 279.85$, $p<.001$, e = .76. The hypothesis of scale mean equality was rejected, Huyn-Feldt $F_{(1.519,\ 1107.081)} = 158.46$, $p<.001$, $\eta^2 = .18$. As it can be observed in Table 4, Bonferroni paired-sample post hoc contrasts showed that SMA mean score was significantly lower than both TOS and PAV mean scores, whereas TOS mean score was significantly higher than PAV mean score. In other terms, in our sample sustainable mobility attitudes were significantly less considered than technological optimism and positive disposition towards automated vehicles, at least as they were operationalized in the SMA, TOS, and PAV scales, respectively. Confirming and extending previous findings (e.g., Tennant et al., 2019), in our study TOS and PAV were positively, significantly, and moderately correlated; rather, SMA scores were independent from measures of technological optimism and positive disposition towards automated vehicles. Participant's years of driving experience were not significantly associated with TOS, $r = -.05$, $p>.10$, and PAV, $r = -.07$, $p>.05$, total scores, while showing a significant and negative, albeit weak relationship with SMA total score, $r = -.14$, $p<.001$.

In our sample, gender comparison could not be carried out on non-binary gender participants because of their small number; a significant multivariate effect of participant's binary gender on TOS, PAV, and SMA scale scores was observed, Hotelling's $T^2 = 496.80$, $F_{(6,\ 1440)} = 8.33$, $p<.001$. Descriptive statistics in male and female participants and Bonferroni *t*-test comparisons of TOS, PAV, and SMA scale mean scores are reported in Table 5. As it can be observed, female participants showed a significantly higher attitude to sustainable mobility than male participants, although the effect size (i.e., Cohen's *d* value) was modest. In line with previous reports, (e.g., Tennant et al., 2019), male participants scored significantly higher than female participants on self-report measures of technological optimism and positive disposition towards automated vehicle drive; however, effect size (i.e., Cohen's *d* values) for these mean differences were in the small-to-moderate range.

No significant multivariate effect of participants' job on TOS, PAV, and SMA scale scores was observed in one-way MANOVA, Pillai's $V = .01$, $F_{(6,\ 1440)} = 1.69$, $p>.10$. Although previous studies (e.g., Hudson et al., 2019) found

Figure 4 – Network structure estimated using Exploratory Graph Analysis)

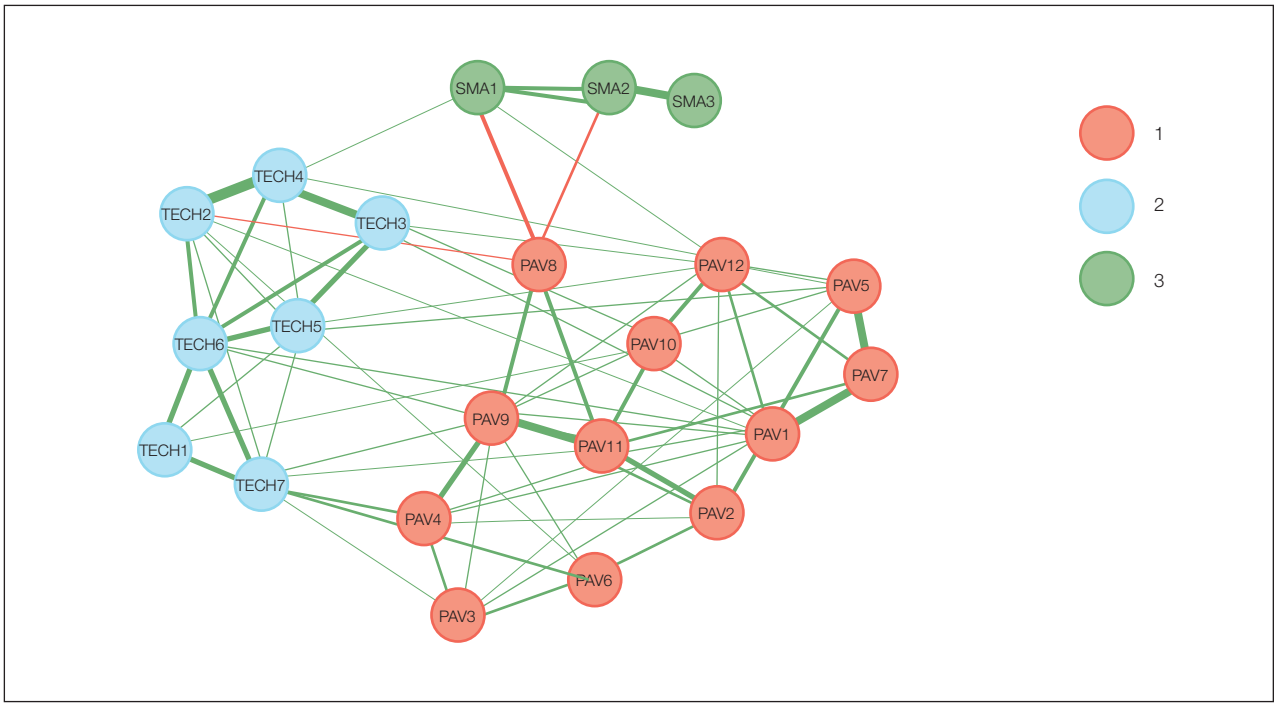


Figure 5 – Bootstrap EGA_{GLASSO} variable stability results

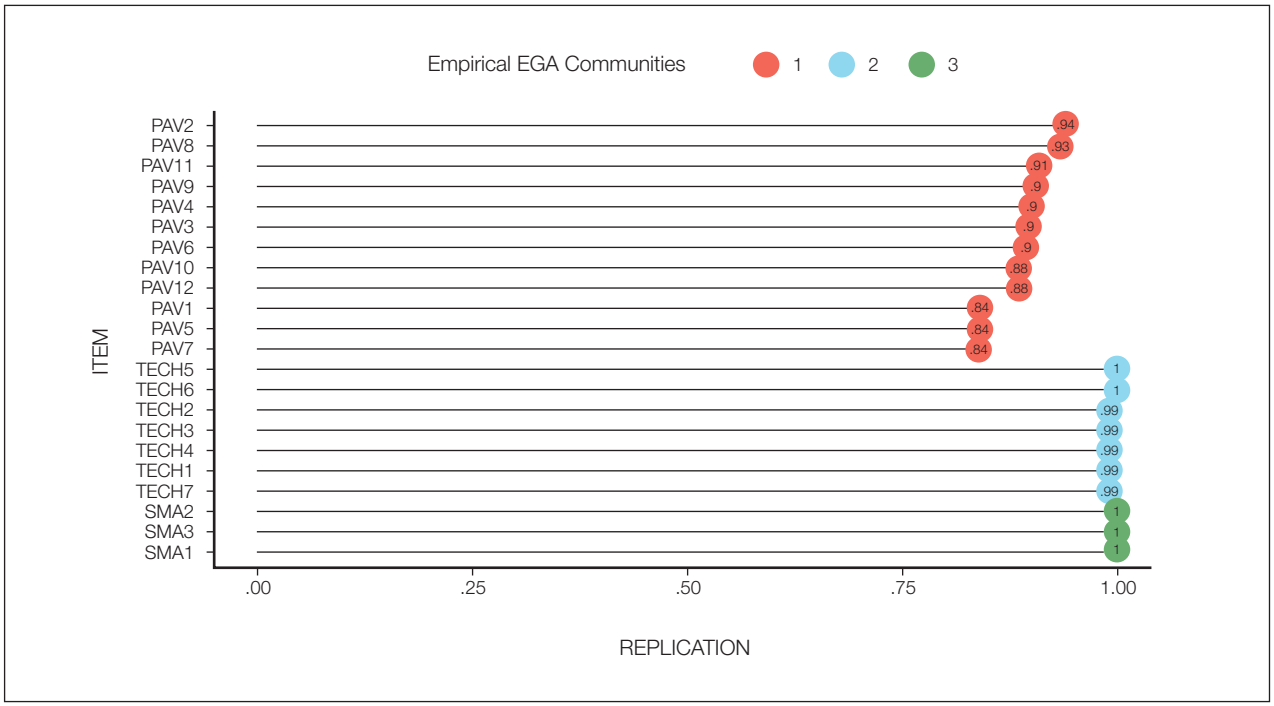


Figure 6 – *Z*-scored centrality metrics (betweenness, closeness, strength) for the Exploratory Graph Analysis model

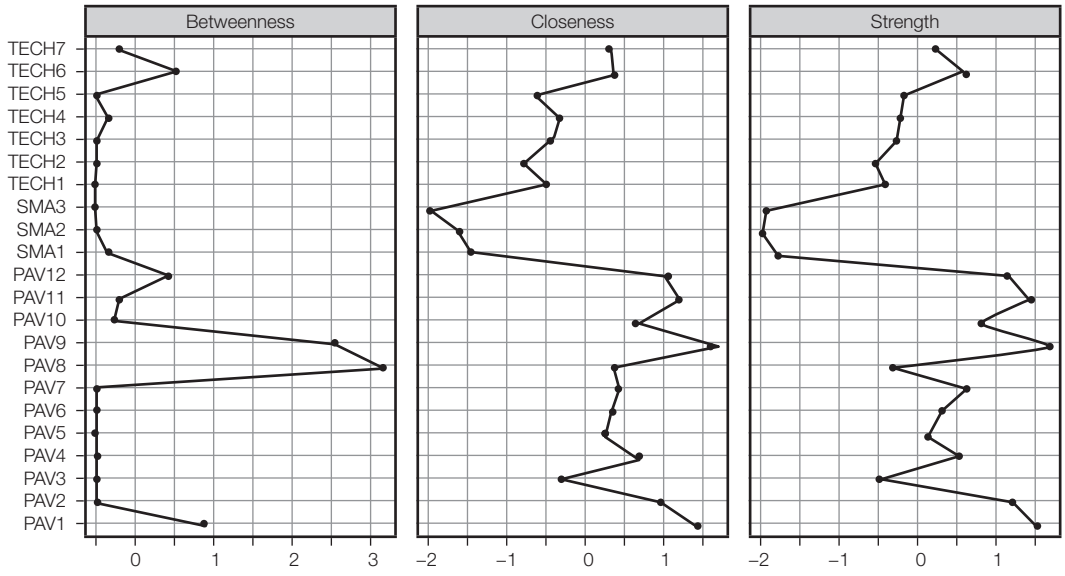


Table 4 – Technological Optimism, Perception of Automated Vehicles, and Sustainable Mobility Attitudes scale scores: descriptive statistics, mean inter-item correlation, Cronbach's alpha value, distribution percentiles, and scale inter-correlations (i.e., Pearson *r* coefficient values) in Italian community-dwelling adult participants (N = 730)

					Distribution percentiles							Pearson *r* values		
Scales	*M*	*SD*	MIC	*α*	*5*	*10*	*25*	*50*	*75*	*90*	*95*	*1*	*2*	*3*
1. TOS	3.23	.66	.32	.77	2.14	2.43	2.86	3.29	3.71	4.13	4.35	–		
2. PAV	2.70	.62	.33	.85	1.67	1.84	2.25	2.75	3.08	3.50	3.67	.37***	–	
3. SMA	2.57	1.03	.42	.68	1.00	1.00	1.67	2.67	3.33	4.00	4.33	.06	−.07	–

Legenda. TOS = Technological Optimism Scale; PAV = Perception of Automated Vehicles Scale; SMA = Sustainable Mobility Attitudes; MIC = Mean inter-item correlation; α = Cronbach's alpha coefficient.
Note. Means with different superscripts were significantly different in Bonferroni paired-sample post-hoc constructs.
*** $p<.001$

Table 5 – Technological Optimism, Perception of Automated Vehicles, and Sustainable Mobility Attitudes scale scores in community-dwelling adult male (n = 276) and female (n = 446) participants: descriptive statistics and Bonferroni mean comparisons

	Male participants (n = 276)		Female participants (n = 446)		Mean comparisons	
	M	*SD*	*M*	*SD*	*t* (720)	*d*
TOS	3.40	.65	3.13	.65	5.53 *	.42
PAV	2.84	.65	2.61	.58	4.89 *	.38
SMA	2.43	.96	2.66	1.07	–2.89 *	.23

Legenda. TOS = Technological Optimism Scale; PAV = Perception of Automated Vehicles Scale; SMA = Sustainable Mobility Attitudes.
Note. The nominal significance level (i.e., $p<.05$) for independent-sample *t*-tests was corrected according to the Bonferroni procedure and set at $p<.0167$.
* $p<.0167$

a negative association between being unemployed or retired and propensity to use AVs, it should be observed that this finding was not unexpected given that our sample was mainly composed by active community members (i.e., 94%). Future studies may address this issue including a larger number of unemployed and retired participants. One-way MANOVA results seemed to indicate a significant multivariate effect of participant's civil status on TOS, PAV, and SMA scale scores, Pillai's $V = .04$, $F_{(9, 2169)} = 3.01$, $p < .01$. However, when the effect of participant's binary gender was controlled for in two-way MANOVA, Pillai's $V = .02$, $F_{(6, 1426)} = 2.59$, $p<.05$, the effect of participant's civil status on TOS, PAV, and SMA scale scores became non-significant, Pillai's $V = .01$, $F_{(9, 2142)} = 1.19$, $p>.20$; no significant gender-by-civil status interaction effect was observed, Pillai's $V = .02$, $F_{(12, 2142)} = 1.12$, $p>.30$. Rather, one-way MANOVA results evidenced a significant multivariate effect of participant's educational level on TOS, PAV, and SMA scale scores, Pillai's $V = .07$, $F_{(9, 2175)} = 5.42$, $p<.001$. Descriptive statistics, univariate *F*-tests, and Bonferroni post hoc contrasts are summarized in Table 6; the nominal significance level (i.e., $p<.05$) of univariate *F*-tests was corrected according to the Bonferroni procedure and set at $p<.0167$. Bonferroni post hoc contrasts were computed only for Bonferroni-significant univariate *F*-tests. In line with previous findings showing that highly educated people tend to show more willingness to use AVs as they perceive them to be safer (e.g., Pettigrew, Talati & Norman, 2018), we found that participants who obtained a graduate and post-graduate degree showed higher PAV scores.

Finally, the Pearson *r* coefficient values for the associations between the TOS, PAV, and SMA scale scores and the BFI scale scores are summarized in Table 7; the nominal significance level (i.e., $p<.05$) was corrected according to the Bonferroni procedure and set at $p<.0033$. As a whole, the relationships between self-reports of Big Five personality dimensions and TOS, PAV, and SMA scale scores were small and non-significant. Technological optimism, at least as it was operationalized in the TOS scale, was positively and significantly, albeit weakly associated with self-reported openness to experience, while showing a modest, negative, and significant association with participant's disposition towards negative affectivity, at least as it was operationalized in the BFI Neuroticism scale. Rather, participant's disposition towards negative affectivity was significantly, positively, and weakly associated with sustainable mobility attitude, at least in our sample of Italian community-dwelling adult participants.

Table 6 – Technological Optimism, Perception of Automated Vehicles, and Sustainable Mobility Attitudes scale scores broken down by educational level: descriptive statistics and Bonferroni mean comparisons

	Junior High School (*n* = 26)		High School (*n* = 301)		Graduate (*n* = 354)		Post-Graduate (*n* = 48)			
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	$F_{(3, 725)}$	η^2
TOS	2.76	.93	3.13	.65	3.33	.63	3.40	.56	10.96 *	.04
PAV	2.36	.76	2.61 [a]	.60	2.76	.61	2.95	.60	8.80 *	.04
SMA	2.41	1.00	2.48	.96	2.63	1.09	2.73	1.08	1.77	.01

Legenda. TOS = Technological Optimism Scale; PAV = Perception of Automated Vehicles Scale; SMA = Sustainable Mobility Attitudes.
Note. The nominal significance level (i.e., $p<.05$) for univariate *F*-tests was corrected according to the Bonferroni procedure and set at $p<.0167$.
Bonferroni post-hoc contrasts were computed only for Bonferroni-significant univariate *F*-tests; within each row, means with different superscripts were significantly different in Bonferroni post-hoc contrast.
* $p<.0167$

Table 7 – The Big Five Inventory Personality scales: descriptive statistics, Cronbach' alpha values, and correlations (i.e., Pearson's r coefficient values) with Technological Optimism, Perception of Automated Vehicles, and Sustainable Mobility Attitudes scale scores in Italian community-dwelling adult participants (N = 730)

	Big Five Inventory Personality scales				
	Openness	*Conscientiousness*	*Extraversion*	*Agreeableness*	*Neuroticism*
TOS	.12*	.04	.02	.06	−.21 *
PAV	.09	−.11	−.04	−.02	−.11
SMA	.07	−.06	−.09	−.02	.14 *
M	36.99	35.32	25.88	33.05	24.36
SD	6.12	5.44	5.86	5.31	5.92
Cronbach's α	.82	.83	.84	.74	.83

Legenda. TOS = Technological Optimism Scale; PAV = Perception of Automated Vehicles Scale; SMA = Sustainable Mobility Attitudes.
Note. The nominal significance level (i.e., $p<.05$) for Pearson *r* coefficients was corrected according to the Bonferroni procedure and set at $p<.0033$.
* $p<.0033$

CONCLUSIONS AND LIMITATIONS

As a whole, our findings seemed to suggest that the short measure assessing positive dispositions towards technology (i.e., TOS), and automated vehicles (i.e., PAV), and sustainable mobility attitudes (i.e., SMA), developed in the present study was provided with adequate psychometric properties, at least in a sample of Italian volunteers who agreed to participate in the present investigation. Moreover, the results of our study may prove useful in integrating Tennant and colleagues' (2019) data on attitudes to driving alongside AVs, focusing on different aspects (e.g., sustainable mobility attitudes), while proving an extensive focus on the Italian context. Finally, the development of a short measure thought to assess dispositions towards AVs may represent the starting point for collecting demographically representative data on the acceptance of AVs, which is considered as a key factor for the success of them (e.g., Othman, 2021). Indeed, the availability of standardized brief measures of positive dispositions towards technology, positive dispositions towards automated vehicles, and sustainable mobility attitudes may enable researchers to embed them in a larger number of studies, which would serve to expedite the process of identifying the key aspects related to the willingness to use AVs. Notably, these short instruments could be used to reliably assess the dispositions towards AVs in large data collection where administration time is valuable and limited.

Of course, the results of the present study should be considered in the light of several, important limitations. Although we relied on a moderately large community-dwelling adult sample, it was composed of adults who volunteered to participate in the study. Thus, it represents a convenient study group rather than a sample representative of the Italian population. Future studies based on representative samples are needed. In the present investigation, participants were adult volunteers who received no incentive for taking part in the research; although no economic interests were at issue, we relied exclusively on self-report questionnaire, with no possibility to rely on observations or interviews. Of course, further studies based on different methods of assessment are badly need before accepting our findings. Moreover, it should be observed that our findings should be considered in the light of the fact that AVs are not widespread adopted; thus, the results largely relied on people's ideas about AVs rather than AVs driving experience (see also, Kyriakidis et al., 2015). Finally, although we relied on sound psychometric methods, we think that independent replications of our findings are needed, possibly considering also vulnerable road users (e.g., pedestrians and bicyclists; Penmetsa et al., 2019) as a relevant research target.

Even keeping these limitations in mind, we think that our findings may represent a useful contribution to the available literature on AVs providing researchers a short measure to assess different aspects contributing to the perception of AVs among community-dwelling participants, at least in Italy. Because public perceptions play a crucial role in wider adoption of AVs (Othman, 2021; Penmetsa et al., 2019), the availability of a standardized measure of dispositions towards technology and automated vehicles, and sustainable mobility attitudes may provide useful data to both researchers and automotive industries.

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SUPPLEMENTARY MATERIAL

Technological Optimism Scale (TOS)

English version

– Science and technology make our way of life change too fast (R)
– I'm not interested in new technologies (R)
– Science and technology are making our lives healthier, easier and more comfortable
– I enjoy making use of the latest technological products and services when I have the opportunity
– New technologies are all about making profits rather than making people's lives better (R)
– I am worried about where all this technology is leading (R)
– Machines are taking over some of the roles that humans should have (R)

Italian version

– La scienza e la tecnologia cambiano il nostro modo di vivere troppo velocemente (R)
– Non sono interessato/a alle nuove tecnologie (R)
– La scienza e la tecnologia stanno rendendo le nostre vite più sane, più facili e più confortevoli
– Mi piace utilizzare gli ultimi prodotti e servizi tecnologici quando ne ho l'opportunità
– Le nuove tecnologie mirano a realizzare profitti piuttosto che a migliorare le vite delle persone (R)
– Sono preoccupato/a per dove sta portando tutta questa tecnologia (R)
– Le macchine stanno prendendo il posto di alcuni ruoli che dovrebbero essere degli esseri umani (R)

Perception of Automated Vehicles Scale (PAV)

English version

– Most accidents are caused by human error so autonomous vehicles would be safer
– I wouldn't mind whether I was driving alongside human drivers or autonomous vehicles (R)
– Autonomous cars could malfunction (R)
– As a point of principle, humans should be in control of their vehicles at all times (R)
– Autonomous cars would behave more predictably than human drivers
– Machines don't have the common sense needed to interact with human drivers (R)
– Machines don't have emotions so they might be better drivers than humans
– I would miss the enjoyment of driving (R)
– I would feel uncomfortable if I wasn't in control of my car (R)
– I would take the opportunity to do other things while the autonomous car takes care of the driving
– It would make no difference to me whether I was in control of the car or not
– Riding in an autonomous car would be easier than driving myself

Italian version

– La maggior parte degli incidenti è causata da errore umano; quindi, i veicoli a guida autonoma sarebbero più sicuri
– Per me non farebbe alcuna differenza se fossi in macchina con conducenti umani o se guidassi veicoli a guida autonoma (R)
– Le auto autonome potrebbero non funzionare correttamente (R)
– In linea di principio, gli esseri umani dovrebbero avere il controllo dei loro veicoli in ogni momento (R)
– Le automobili a guida autonoma si comporterebbero in modo più prevedibile dei conducenti umani
– Le macchine non hanno il buon senso necessario per interagire con i conducenti umani (R)
– Le macchine non hanno emozioni, quindi potrebbero essere dei conducenti migliori degli umani
– Mi mancherebbe il piacere di guidare (R)
– Mi sentirei a disagio se non avessi il controllo della mia automobile (R)
– Coglierei l'occasione per fare altre cose mentre l'automobile a guida autonoma si occupa della guida
– Non farebbe differenza per me se avessi il controllo dell'automobile o no
– Guidare un'automobile a guida autonoma sarebbe più facile che guidare io stesso

Sustainable Mobility Attitudes (SMA)

English version

– I do not know whether I can use leaded gas in my automobile
– I usually drive on freeways at speeds under 60 mph
– When possible in nearby areas (around 20 miles), I use public transportation or ride a bike

Italian version

– Non so se posso utilizzare benzina al piombo per la mia automobile (R)
– Generalmente, in autostrada guido a meno di 130 km/h
– Quando possibile per raggiungere mete vicine (circa 30 km), uso i trasporti pubblici o la bicicletta