Research in Developmental Disabilities 94 (2019) 103460

Contents lists available at ScienceDirect

Research in Developmental Disabilities

journal homepage: www.elsevier.com/locate/redevdis

Psycholinguistic profile of young adults with Down syndrome

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ARTICLE INFO

Keywords:
Down syndrome
Intellectual disability
Adults
Psycholinguistic profile
Auditory processing
Visual processing

ABSTRACT

Background: The phenotype of Down syndrome (DS) is usually characterized by relative strengths in visual skills and severe deficits in auditory processing; this has consequences for language and communication. To date, it is not known whether this pattern characterizes the psycholinguistic profile of young adults with DS.
Aims: This study aimed to assess whether, relative to their cognitive level, young adults with DS present a specific and homogeneous phenotype for both auditory and visual psycholinguistic skills.
Methods and procedures: Fifty young adults with DS and 50 peers with other intellectual disability (ID) were equated in chronological age and nonverbal cognition and were compared regarding their performance in auditory and visual psycholinguistic functions.
Outcomes and results: Participants with DS showed more phenotypic-specific deficits in auditory psycholinguistic skills than in those involved in visual processing. However, phenotypic-specific impairments in visual psycholinguistic skills were also observed, while no significant between-group differences were found for some auditory psycholinguistic skills.
Conclusions and implications: The psycholinguistic pattern of young adults with DS is not homogeneous with respect to auditory and visual processing. The profile of specific deficits suggests that the educative support for young adults with DS may need to be specific.

What this paper adds

The language studies of young adults with Down syndrome (DS) have been traditionally underrepresented in the literature; thus, there is a need to expand our knowledge of the DS phenotype at this age. Individuals with DS are generally described as having pronounced deficits in auditory processing but relative strengths in visual skills; this pattern may have consequences for the way this group uses language. We studied, for the first time, whether the differential pattern in auditory and visual psycholinguistic skills described for those with DS homogeneously characterizes the psycholinguistic profile of young adults. By comparing psycholinguistic skills related to auditory or visual processing in a large group of participants with DS and peers with other intellectual disability (ID) equated in chronological age and nonverbal cognition, we observed that the psycholinguistic profile of young adults with DS was not homogeneous. Participants with DS showed more phenotypic-specific deficits in auditory psycholinguistic skills than in those involved in visual processing. However, phenotypic-specific impairments in visual psycholinguistic skills were also observed, while no significant between-group differences were found for some auditory psycholinguistic skills. The heterogeneity in the auditory and visual processing-related psycholinguistic skills of young adults with DS is a novel finding and allows a better description of their

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https://doi.org/10.1016/j.ridd.2019.103460
Received 4 January 2019; Received in revised form 13 July 2019; Accepted 4 August 2019
Available online 30 August 2019
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specific phenotype. This is relevant because, as previously stated, the language studies of adults with DS are relatively scarce. Furthermore, given that young adults with DS need to continue learning, the specific observed profile suggests that they should be provided with specific educative support.

1. Introduction

1.1. The relevance of studying the phenotype of young adults with Down syndrome

Down syndrome (DS) is the most common genetic syndrome associated with intellectual disability (ID) and, as such, has been the focus of many studies (Fidler & Nadel, 2007). Individuals with DS show a specific phenotype that distinguishes them from individuals with other syndromes (Dykens, Hodapp, & Evans, 1994; Grieco, Pulsifer, Seligsohn, Skotko, & Schwartz, 2015). Language impairment is present in 95% of cases (Miller, Leddy, & Leavitt, 2001), and speech and language disorders of individuals with DS are among the most important and constraining challenges they must manage (Abbeduto et al., 2003; Chapman & Hesketh, 2001).

While language development has been widely investigated in children with DS, the language studies of adults with DS have been traditionally underrepresented (Finestack & Abbeduto, 2010; Iacono, Torr, & Wong, 2010; Kumin, 2015; Witecy & Penke, 2017). However, the linguistic profile of individuals with DS differs along the life span (Chapman, 2006; Kumin, 2015). Similar to that observed in childhood, vocabulary understanding in young adulthood is higher than syntactic comprehension (Laws & Bishop, 2003). However, compared with the vocabulary size of children, that of teenagers and adults with DS is larger, and their expressive language skills continue to increase (Chapman, 2006; Chapman, Hesketh, & Kistler, 2006). Although inconsistent results have been observed regarding syntactic comprehension in adulthood, a plateau seems to be reached at this age (Witecy & Penke, 2017). Aging and dementia due to Alzheimer's disease also have an impact on the language skills of older adults with DS (Iacono et al., 2010).

The increase in the life expectancy of individuals with DS (Bittles & Glasson, 2004) together with the high risk of Alzheimer's disease that adults with DS present from the age of 40 years (Firth et al., 2018) have awakened the interest in studying the phenotype of older adults with the syndrome (Karmiloff-Smith et al., 2016). However, there is also a need to increase our knowledge of the phenotype of younger adults with DS (Finestack & Abbeduto, 2010). At this age, they continue learning and try to become prepared to participate, later on, in the labor market. Better characterization of their strengths and weaknesses and distinguishing their specific phenotype from that of other individuals who also present with ID could inform professionals' educational practices and methods (Fidler & Nadel, 2007; Grieco et al., 2015; Kumin, 2015). Such improved understanding would have a positive impact on the provision of support for individuals with DS that would ultimately contribute to enhancing their quality of life (Grieco et al., 2015).

1.2. Usefulness of the model of the Illinois Test of Psycholinguistic Abilities

The design of educative support for individuals with DS or other developmental disorders should consider the existence of different learning styles and preferred pedagogical approaches to be used depending on the individual's main perception and answer mode (Fidler & Nadel, 2007). Distinguishing the auditory and visual routes of information processing may be particularly useful for such an aim (Moya, Hernández, Hernández, & Cózar, 2009). These two information routes are clearly distinguished in the psycholinguistic model developed by Kirk and McCarthy (1961) that has been the basis for the design of the Illinois Test of Psycholinguistic Abilities (ITPA) (Kirk, McCarthy, & Kirk, 1968/2011Kirk et al., 2011Kirk, McCarthy, & Kirk, 1968/2011).

This model is based on the idea that language involves complex processes related to both visual and auditory information (Garman, 1990). Thus, in the model, the visual and auditory information routes are related to the processes linked to acquisition and use of language: decoding (receptive language), association (manipulating linguistic symbols internally) and encoding (expressive language). The model also considers the psychological functions involved in perceiving, interpreting and conveying messages. Consequently, for both the auditory and visual routes, not only the psycholinguistic skills of reception, association and expression but also those related to memory and closure are deemed to be relevant (Kirk et al., 2011). As previously underlined, by distinguishing the auditory and visual routes of information processing, this psycholinguistic model may be especially useful when working with individuals with DS. Thus, in this group, uneven auditory and visual skills have been reported (e.g., Grieco et al., 2015).

1.3. Visual and auditory processing skills of individuals with Down syndrome

Individuals with DS are usually described as having both relative strengths in visual skills and severe deficits in auditory processing (Chapman & Hesketh, 2001; Jarrold & Baddeley, 1997; Yang, Conners, & Merrill, 2014). Due to their difficulties in processing auditory information, especially the more complex information, individuals with DS perform higher on visuospatial than on verbal tasks (Klein & Mervis, 1999). Provided that the linguistic stimuli can be either visual or auditory, the difference between visuospatial and verbal skills may have consequences for the acquisition and use of language. Thus, individuals with DS experience more difficulties elaborating oral language than using gestures as a means of expression (Lorang, Sterling, & Schroeder, 2018; Stefanini, Caselli, & Volterra, 2007).

The relative strength of visuospatial skills in DS has led to promoting the use of visual strategies as intervention tools (Buckley, 1985); in fact, the learning of children with DS seems to be facilitated when using visual supports (Buckley, Bird, & Byrne, 1996; Cupples & Iacono, 2002). Nevertheless, it should be mentioned that the profile of visuospatial skills in DS is not homogeneous (Yang et al., 2014). Furthermore, when the general cognitive ability level is taken into account, visuospatial ability may not be considered a relative strength after all (Wan, Chiang, Chen, Wang, & Wuang, 2015; Yang et al., 2014).

The difficulties with processing auditory information by individuals with DS seem to be widespread. Individuals with DS present slower auditory speed processing that results in delays for auditory stimuli orientation and categorization (Díaz & Zurron, 1995; Lincoln, Courchesne, Kilmany, & Galambos, 1985; Seidl et al., 1997). They also show difficulties with speech discrimination and word identification (Marcell, 1995). These difficulties may lead them to avoid paying attention and listening to auditory stimuli (Dierssen & Flórez, 2007), which, in turn, ends up reducing the entry of this type of information (Ruiz, 2013). The skills related to focusing consciously on the sound structure of language -i.e., phonological awareness (Cupples & Iacono, 2000)- are also impaired in DS (Snowling, Hulme, & Mercer, 2002). Thus, children, adolescents and adults with DS perform poorly on tasks that involve manipulating the phonological segments of language, such as rhyme and alliteration judgments, phoneme blending or phoneme segmentation (Cupples & Iacono, 2000; Fletcher & Buckley, 2002; Snowling et al., 2002). Weakness in phonological processing can also be observed when considering phonological memory. Individuals with DS present poor verbal short-term memory, with performance of this type of memory, in turn, being lower than that for visuospatial information (Jarrold & Baddeley, 1997; Jarrold, Baddeley, & Phillips, 2002). This specific deficit in short-term memory for auditory information (Jarrold & Baddeley, 1997) has a negative impact on vocabulary acquisition (Jarrold, Baddeley, & Philips, 2002) and sentence comprehension and expression (Laws, 2004; Miolo, Chapman, & Sindberg, 2005). Despite the phonological deficits, both phonological awareness and verbal memory span can be improved in individuals with DS through targeted intervention programs (Conners, Rosenquist, Arnett, Moore, & Hume, 2008; Lemons & Fuchs, 2010).

1.4. Scope and aim of the study

As previously mentioned, a better description of the specific phenotype of young adults with DS could positively impact educational methods. In this respect, it should be noted that, to our knowledge, no prior research has investigated the psycholinguistic profile of young adults with DS by considering the different functions involved in language and communication, distinguishing, at the same time, the different channels (visual or auditory) of information transmission (Kirk & McCarthy, 1961). Although young adults are expected to present severe impairments in the psycholinguistic skills related to auditory information processing, the extent of the impairment in the auditory channel is not fully known. Additionally, visual functions seem to be heterogeneous in individuals with DS (Yang et al., 2014). Therefore, it is unclear whether the differential pattern related to auditory and visual information usually reported for DS homogeneously characterizes the psycholinguistic skills of young adults with DS. Our research aimed to clarify this issue. To this end, the psycholinguistic skills involved in processing auditory and visual information as defined by Kirk et al. (2011) were studied in a large group of young adults with DS compared with a group of peers with other ID of the same chronological age and cognitive level.

2. Method

2.1. Participants

The sample comprised 100 young adults, divided into two groups: a group of 50 participants with DS and a group of 50 individuals with other ID. All participants with DS had confirmed trisomy 21 without mosaicism, while the ID of participants in the second group was of unknown origin. Following prior research (e.g., Abbeduto et al., 2003; Chapman, 2006; Finestack & Abbeduto, 2010), the two groups were equated in chronological age ($p = .10$) and nonverbal cognition ($p = .66$), as measured by the raw scores obtained on the matrices subtest of K-BIT (Kaufman & Kaufman, 2000). The age range of participants was 18–26 years. It should be noted that, at these ages, no cognitive decline is shown in DS (Oliver, Crayton, Holland, Hall, & Bradbury, 1998). Descriptive characteristics of the two groups of participants are presented in Table 1.

All participants had oral language, spoke Spanish and were monolingual. According to the parental report, participants had no history of hearing impairment or another developmental disorder. Participants were recruited from a local foundation for individuals with DS and other ID. All were students of a postcompulsory education program at such a foundation. This program was part of the educational policy of the region where the study was conducted. The program, which had no entry requirements, aimed that participants acquired core skills for their personal, social and professional development. Although there were no reports of mental health disorders, some participants were receiving psychological therapy to improve their socioemotional well-being (42% of participants with DS and 34% of participants with other ID).

Table 1
Descriptive Characteristics of the Group with DS and the Group with other ID.

	Group with DS	Group with other ID
N	50	50
Gender (M/F)	19/31	24/26
Chronological age (years)	22.60 (2.20)	21.90 (2.00)
Matrices – K-BIT (raw score)	16.54 (5.32)	16.96 (4.04)

Note: Standard deviations are presented in brackets.

2.2. Materials

The ITPA was administered to participants in its standardized version in Spanish (Kirk et al., 2011). This test allows a detailed assessment of psycholinguistic skills related to the processing of auditory or visual information. The processes of reception, association, expression, closure and memory are evaluated by distinguishing the two channels (auditory and visual) information can be expressed through. These processes are assessed using 11 subtests. The processes and their subtests are described below.

Reception refers to the skill to understand what is heard or seen. The *auditory reception* subtest assesses the ability to obtain meanings from orally presented verbal information, and the *visual reception* subtest evaluates the skill of obtaining meanings from visual symbols.

Association refers to the skill to internally relate concepts and linguistic symbols. The *auditory association* subtest uses verbal analogies to evaluate the ability to establish relationships among orally presented concepts. In the *visual association* subtest, testees have to choose the picture that better relates with another target picture; thus, this subtest assesses the ability to relate visually presented concepts.

Expression refers to the skill to produce meaningful ideas either orally or through gestures. *Verbal expression* evaluates oral fluency, and *motor expression* assesses the ability to express meanings using gestures.

Closure refers to the skill to complete the omitted parts of a visual or an auditory stimulus and, thus, the process of integrating different parts in a whole. This process is evaluated using the following three subtests. *Grammatical closure* evaluates the ability to use grammar for utterance completion. *Auditory closure* assesses the ability to complete words presented without some sounds. *Visual closure* assesses the skill of identifying known masked objects in a visually complex context.

Memory refers to the skill to remember and reproduce phonological or visual stimuli that have been previously presented. The *auditory sequential memory* subtest assesses the immediate forward recall of digit sequences, and *visual sequential memory* evaluates the ability to reproduce sequences of meaningless pictures from memory.

The test is suitable to assess individuals with functional levels equivalent from 3 to 10 years. Cronbach's alpha reliability is at least 0.90 for 30% of the results, and the lowest coefficient is 0.74.

Apart from the ITPA (Kirk et al., 2011), to obtain a measurement of vocabulary comprehension, the standardized Spanish version of the Peabody Picture Vocabulary Test, Third Edition (PPVT-III) (Dunn & Dunn, 2010), was administered to participants. This test is appropriate for individuals aged 2.5–90 years. Split-half reliability ranges from 0.89 to 0.99 for all ages, and test-retest reliabilities range from 0.91 to 0.94 for all ages.

As previously mentioned, the matrices subtest of K-BIT (Kaufman & Kaufman, 2000) was used to assess the participants' nonverbal cognition. This subtest, suitable from 4 to 90 years, was also used in its Spanish standardized version. Split-half reliability ranges from 0.74 to 0.93 for all ages, and the mean test-retest reliability is 0.86.

2.3. Procedure

All the tests were individually administered in a quiet room of the local foundation for individuals with DS and other ID, in which participants were enrolled in education programs. First, the nonverbal cognition level, as assessed by the matrices subtest of K-BIT (Kaufman & Kaufman, 2000), was evaluated by a psychologist of the foundation. Second, PPVT-III (Dunn & Dunn, 2010) and ITPA (Kirk et al., 2011) were administered by the first author of this work. Each assessment took one and a half hours with a break in the middle of the session.

All the parents and participants provided their informed consent to participate in the study. The study was performed in agreement with the ethical principles of the Declaration of Helsinki.

3. Results

Before running between-group comparisons on the variables of interest (ITPA and PPVT-III performance), we first assessed the appropriateness of our matching procedure. The two groups of study did not significantly differ in chronological age, as previously mentioned. However, the p level obtained for this comparison ($p = .10$) was below .50, the criterion commonly accepted to assume real matching (Mervis & Klein-Tasman, 2004). To ensure that the groups were well-equated in this variable, we also calculated effect sizes and variance ratios because these two measurements represent good indices of group equivalence (Kover & Atwood, 2013). Both measurements suggested that the groups were appropriately equated in chronological age ($r = .16$, $s^2_{DS}/s^2_{ID} = 1.20$). When considering the matching in nonverbal cognition, the p level ($p = .66$) and effect size ($r = .04$) were good enough to ensure between-group equivalence (Kover & Atwood, 2013). However, the variance ratio was relatively high ($s^2_{DS}/s^2_{ID} = 1.73$).

The combined use of the three indices suggests that the group with DS and the group with other ID were equated both in chronological age and nonverbal cognition. However, we reduced the number of participants in each group to obtain two groups (46 participants per group) in which the three indices were suggestive of appropriate matching both for chronological age ($p = .53$, $r = .07$, $s^2_{DS}/s^2_{ID} = 1.23$) and nonverbal cognition ($p = .66$, $r = .05$, $s^2_{DS}/s^2_{ID} = 1.10$). To compare between-group performance, the raw scores obtained in each of the subtests of ITPA (Kirk et al., 1968/2011) and in PPVT-III (Dunn & Dunn, 2010) were analyzed with independent t-tests for both the reduced group of participants and whole sample[1]. The same findings were obtained with the reduced

[1] Multiple t-tests were preferred over omnibus MANOVA because the focus of this research was not placed on the combined effect of all the ITPA

Table 2
Results obtained by the Group with DS and the Group with other ID.

	Group with DS	Group with other ID
Auditory reception (ITPA) *	19.82 (14.50)	27.28 (14.48)
Visual reception (ITPA)	23.92 (5.10)	23.60 (7.52)
Auditory association (ITPA) ***	19.12 (10.27)	27.60 (7.69)
Visual association (ITPA) **	22.82 (7.18)	26.72 (6.70)
Verbal expression (ITPA)	44.10 (17.00)	46.98 (15.59)
Motor expression (ITPA)	22.70 (4.61)	22.12 (4.72)
Grammatical closure (ITPA) ***	18.10 (8.34)	24.32 (6.63)
Auditory closure (ITPA)	18.78 (6.73)	20.50 (6.90)
Visual closure (ITPA) ***	24.98 (10.23)	32.92 (11.24)
Auditory sequential memory (ITPA) **	6.22 (3.74)	9.66 (5.92)
Visual sequential memory (ITPA)	14.22 (6.11)	12.24 (6.23)
Vocabulary comprehension (PPVT-II) **	77.34 (22.71)	95.14 (27.43)

Note: Standard deviations are presented in brackets.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

and complete groups. Thus, for the sake of statistical power, we report the results of the whole sample. The results are presented in Table 2. The significant results found for each psycholinguistic process survived Bonferroni correction.

Considering the ITPA (Kirk et al., 2011), participants with DS performed significantly lower ($t(98) = 2.57$, $p = .012$, $r = .25$) on auditory reception. However, no significant differences were found between the groups in visual reception ($p > .05$). On both auditory association and visual association, the group with DS performed significantly lower than the group with other ID ($t(98) = 4.67$, $p < .001$, $r = .43$, and $t(98) = 2.81$, $p = .006$, $r = .27$, respectively). Regarding language expression, no significant differences were observed in either verbal expression ($p > .05$) or motor expression ($p > .05$). For the closure subtests, participants with DS performed significantly lower than their peers with other ID on grammatical closure ($t(98) = 4.13$, $p < .001$, $r = .38$) and visual closure ($t(98) = 3.69$, $p < .001$, $r = .35$). However, no significant differences were observed for auditory closure ($p > .05$). The results for auditory sequential memory were significantly lower in the group with DS than in the group with other ID ($t(98) = 3.47$, $p = .001$, $r = .33$), while no between-group significant differences were observed for visual sequential memory ($p > .05$).

Considering vocabulary comprehension, as measured by the PPVT-III (Dunn & Dunn, 2010), the group with DS performed significantly lower than the group with other ID ($t(98) = 3.53$, $p = .001$, $r = .34$).

4. Discussion

4.1. Results on auditory and visual psycholinguistic processes

In this study, we compared the psycholinguistic skills of two large groups of young adults with DS and peers with other ID equated in chronological age and nonverbal cognition. By carrying out this comparison, we assessed whether young adults with DS present a specific and homogeneous psycholinguistic phenotype across a range of different processes related to language and communication (memory, reception, association, closure, and expression) in both the auditory and visual channels.

4.1.1. Memory

The expected profile was observed in the memory psycholinguistic processes. Thus, performance on the auditory sequential memory was significantly lower for participants with DS than that for their peers with other ID. However, no between-group significant differences were observed for the visual counterpart of the task, i.e., visual sequential memory. These results are consistent with the literature. Prior evidence showed that, compared with children or young adults with other ID, those with DS present deficits in forward digit span tasks (Chapman, 2006; Jarrold & Baddeley, 1997; Jarrold et al., 2002; Marcell & Weeks, 1988). For visual sequential memory, previous studies also observed no significant differences between the two groups of individuals (Jarrold & Baddeley, 1997; Jarrold et al., 2002; Wan et al., 2015).

4.1.2. Reception

The same pattern of results was observed for the reception process. Thus, regarding the auditory reception task, the group with DS performed significantly lower than the group with other ID, while no between-group significant differences were found on the visual

(*footnote continued*)
variables together. Instead, the paper was aimed to assess separate psycholinguistic skills as defined by Kirk et al. (2011) both in the auditory and visual channels. Even though, when running MANOVA, the main effect of group was significant for all the MANOVA test statistics ($p < .001$). The results of the univariate statistics found with this test were the same as those obtained when the individual t-tests were run separately.

reception task. The lack of between-group significant differences in the visual reception task is consistent with previous studies (Costanzo et al., 2013; Klein & Mervis, 1999). The lower performance of the group with DS on the verbal reception task is also consistent with prior work. Thus, previous research also concluded that the problems with receptive language experienced by teenagers and adults with DS are more severe than what would be expected for their nonverbal cognitive level (Abbeduto et al., 2003; Chapman & Hesketh, 2001). The verbal reception task included in the ITPA requires participants to obtain meaning from orally presented information both in simple utterances and in complex speech (Kirk et al., 2011). The deficits exhibited by participants with DS in this task may be related to different factors in interaction. First, these deficits may be accounted for by participants' difficulties in grammar comprehension (Abbeduto, Evans, & Dolan, 2001; Chapman, 1997; Laws & Bishop, 2003). In turn, grammar comprehension could be explained by impairments individuals with DS present in auditory short-term memory (Miolo et al., 2005; Witecy & Penke, 2017). Moreover, difficulties with auditory discrimination may lead individuals with DS to be less attentive when presented with oral information (Dierssen & Flórez, 2007).

The difficulties with receptive language of young adults with DS were also shown when assessing vocabulary comprehension using the PPVT-III test (Dunn & Dunn, 2010). In this test, the performance of the group with DS was significantly lower than that of the group with other ID. Previous studies have also observed that adolescents and young adults with DS have significantly lower vocabulary comprehension levels than those of individuals with other ID matched in nonverbal cognition (Chapman, 2006; Finestack & Abbeduto, 2010).

4.1.3. Association

Unlike the processes of memory and reception, for association, we did not observe the differential pattern for the auditory and visual tasks that participants with DS would be expected to present compared with peers with other ID. Thus, for both the auditory and visual association tasks, participants with DS performed significantly lower than the control group with other ID. Both tasks involve the ability to relate concepts. Knowledge elaboration and semantic knowledge are impaired in individuals with DS (Miller et al., 2001). These difficulties could explain the deficits participants with DS showed in both the auditory and visual association tasks. Therefore, regardless of the channel information is presented through, there seems to be a generalized deficit in establishing conceptual relationships and category generation.

4.1.4. Closure

The expected pattern was not observed for the closure tasks either. Only for the grammatical closure task were the results consistent with the common description of the DS phenotype. Thus, regarding this task, participants with DS performed significantly lower than their counterparts with other ID. Cross-linguistic research has shown that children and adults with DS who are native speakers of different languages (e.g., English, Italian, Serbo-Croatian) experience difficulties with grammar (e.g., Abbeduto et al., 2003; Caselli, Monaco, Trasciani, & Vicari, 2008; Perovic, 2008). Prior research in Spanish has also shown deficits in this respect (Sepúlveda, López-Villaseñor, & Heinze, 2013). Therefore, our results on grammatical closure were to be expected.

However, contrary to traditional descriptions of the visual skills of individuals with DS (for a review, see Yang et al., 2014), in the visual closure task, participants with DS also performed significantly lower than their peers with other ID. Perhaps more surprisingly, in the auditory closure task, no significant differences were observed between the groups. Therefore, the results on the visual closure and auditory closure tasks clearly contrast with the idea that, compared with the cognitive level of individuals with DS, only the psycholinguistic skills related to auditory information, rather than visual information, are impaired.

The results obtained for auditory closure were unexpected. Thus, for other similar auditory processing tasks, such as word identification or speech discrimination, young adults with DS perform significantly lower than individuals with other ID matched in chronological age and cognitive level (Marcell, 1995). Instead, in our study, the group with DS performed at the same level as the group with other ID. The auditory closure task required participants to complete words that were presented with missing sounds. Considering the nature of the task, the results could be accounted for by two reasons. First, it should be considered that the group with DS was participating in a postcompulsory education program in which reading tasks were carried out daily. Reading requires metalinguistic skills, such as phoneme segmentation and grapheme-phoneme correspondence; at the same time, learning to read may facilitate training in phonological skills (Gallego, 2001); this could explain the high results obtained by the group with DS. Second, the social function of language and communication should also be considered when explaining the results for auditory closure. Young adults with DS establish relationships with other young adults with language and speech articulation problems. Consequently, they may need to develop compensatory strategies to ensure successful peer communications. These compensatory strategies may involve a top-down analysis, in which meaning could overcome the loss of phonological information. We suggest that compensatory strategies of this kind may enhance phonological processing that, in turn, would contribute to explaining the relatively high results participants with DS obtained on the auditory closure task. This hypothesis is consistent with the claims that educational settings may have the potential to modify phenotypic profiles (Fidler & Nadel, 2007). Prior research suggested how the social challenges imposed on children with DS by attending inclusive schools could lead such children to not exhibit the adaptive communication problems that are usually reported for the DS phenotype (Buckley, Bird, & Sacks, 2006). In our study, the young adults with DS participated in a postcompulsory education program for individuals with ID. In this setting, the social challenges linked to the need to successfully communicate with peers with language and speech problems could be associated with the performance observed on the psycholinguistic skill of auditory closure.

The results for visual closure do not support the view of individuals with DS as having strength in visual skills (Yang et al., 2014). However, they are in agreement with prior data. Thus, in previous studies in which visual closure was assessed through tasks similar to that included in the ITPA (Kirk et al., 2011) (i.e., tasks requiring participants to find an object or a figure within a larger scene),

individuals with DS have also been observed to perform lower than peers with other ID (Vicari, Belluci, & Carlesimo, 2006). This finding suggests that individuals with DS have deficits in visual closure, as already pointed out in other work (Yang et al., 2014).

4.1.5. Expression

Finally, regarding the visual and auditory routes of the expression process assessed in the ITPA test (Kirk et al., 2011) through the motor expression and verbal expression tasks, respectively, no significant differences were observed between groups. Compared with typically developing children, those with DS are said to present a "gestural advantage" (Caselli et al., 1998) that is likely due to the difficulties that children with DS encounter with oral language (Franco & Wishart, 1995). Thus, it is unsurprising that, by adulthood, individuals with DS do not show phenotypic-specific deficits in the use of gestures to express meanings, i.e., the skill assessed in the motor expression task.

Verbal expression is described as severely impaired in individuals with DS (Chapman, 1997). However, as aforementioned, no significant differences were observed between the two groups in the study on the verbal expression task of the ITPA (Kirk et al., 2011). Although our results may seem inconsistent with those of previous studies on DS, they are actually in agreement with prior data on the language skills of adults with this syndrome. Thus, it should be considered that the verbal expression task of the ITPA (Kirk et al., 2011) measures semantic fluency. In this type of task, prior studies have also observed that the performance of adults with DS is at the level of peers with other ID (Rowe, Lavender, & Turk, 2006) or of typically developing children matched on mental age (Carney, Brown, & Henry, 2013).

4.2. Strengths and limitations of the study

The results of the study extend our knowledge of the psycholinguistic phenotype of young adults with DS. This is relevant because, as previously mentioned, language studies of adults with DS are relatively scarce (Finestack & Abbeduto, 2010; Iacono et al., 2010; Kumin, 2015; Witecy & Penke, 2017). We assessed a large group of participants with DS, strengthening the study.

Participants in this study were native speakers of Spanish. Most of the research focused on language in DS has been conducted in English. It is important to study the language skills of individuals with DS in different languages because cross-linguistic differences may arise. Although no cross-linguistic comparisons were performed in this research, the consistency of our data with prior results found in English (e.g., Abbeduto et al., 2003; Chapman, 2006; Finestack & Abbeduto, 2010) suggests that some linguistic difficulties (e.g., in vocabulary comprehension and grammatical closure) could be language-universal in DS, as already acknowledged in the literature (e.g., Perovic, 2008). Nevertheless, it should also be mentioned that Spanish is morphologically richer than English. The use of finer-grained language assessment tools may lead to finding subtle cross-linguistic differences when assessing Spanish-speaking adults with DS. Future studies should clarify this issue.

The ITPA includes subtests that assess cognitive processes necessary to give meaning to what is heard (e.g., auditory reception). This allows us to make some inferences about how language is used in everyday life. Nevertheless, it should be considered that, as usual with language tests, the ITPA also presents limited ecological validity.

Additionally, although hearing problems are common in individuals with DS (Marcell, 1995), no objective audiological assessment was conducted. This is another limitation of our research. Instead, similar to other studies (e.g., Witecy & Penke, 2017), hearing impairment was only assessed through parental report. No parents reported such a problem. This observation suggests that all participants had functional hearing. It also suggests that, if hearing impairment was present in any participant, it was likely very mild. Consequently, performance on auditory processing tasks would not be biased by potential hearing problems. Nonetheless, future studies continuing this line of research should also include audiological assessments.

The specificity of the psycholinguistic profile of young adults with DS was assessed using comparisons with matched-peers with ID of unknown origin. Although this procedure is usual in the literature (e.g., Chapman, 2006), it involves limitations. Thus, a group of participants with ID of unknown etiology does not preclude the possibility that some of the participants in this group did actually have a specific, although undiagnosed, phenotype, and this could impact the results of the study.

4.3. Conclusions and implications

In this research, we have studied a range of psycholinguistic skills related to either auditory or visual processing in participants with DS. By considering traditional descriptions of the DS phenotype (Chapman & Hesketh, 2001; Yang et al., 2014), when comparing young adults with DS and peers with other ID equated in chronological age and nonverbal cognition, one would have expected to observe a psycholinguistic profile in DS characterized by phenotypic-specific deficits in auditory processing related to language and communication, and no phenotypic-specific impairments in visual information processing. This pattern was observed for the psycholinguistic processes of reception and memory. However, different results were observed for other processes. Thus, an opposite pattern was observed in auditory and visual closure. Moreover, for association, phenotypic-specific deficits were observed regarding both the auditory and visual channels, while no deficits (with regard to cognitive level) were observed in the expression process in either the auditory or visual routes. Therefore, although phenotypic-specific deficits were found in a higher number of auditory processing-related psycholinguistic skills than in those involved in visual processing, this specific pattern was not homogeneous. Phenotypic-specific deficits were also observed in some visual processing skills (visual association and visual closure), and skills commensurate with cognitive level were observed for auditory closure and verbal expression.

Overall, on the visual tasks of the ITPA (Kirk et al., 2011), young adults with DS performed either lower than or at the same level as peers with other ID. Therefore, our results support the claims that the visuospatial skills in DS are uneven and, relative to the

general cognitive level, do not represent a strength (Yang et al., 2014). However, as already mentioned, more phenotypic-specific deficits were found on the auditory than the visual psycholinguistic tasks.

It should be noted that both within-syndrome variability and between-syndrome similarities can be found when considering phenotypic outcomes; therefore, specific phenotypes should be considered in probabilistic terms (Dykens, 1995). Even though, characterizing the phenotype associated with DS in each developmental stage can have a very positive impact in the education practice aimed to individuals with this disorder (Fidler & Nadel, 2007). The profile of specific deficits observed in young adults with DS compared with peers with other ID leads us to emphasize that the educative support for these young adults may also need to be specific. At this age, educative support may be provided to increase the likelihood of young adults with ID entering the labor market; thus, specialized professional training programs for these individuals are currently being fostered (Moreno, Crespo, & Julia, 2012). The groups in these programs are usually very heterogeneous, including participants with different developmental disorders. However, professionals involved in these (or other) programs should not forget the specificity of phenotypic profiles that is also observed in young adulthood. In the case of young adults with DS, in general, the specific deficits observed in auditory processing-related psycholinguistic skills suggest that, similar to in childhood (Buckley, 2003), learning processes may be enhanced by using visual supporting tools. Strategies with auditory cues may also be used. Thus, verbal reinforcement, self-instruction training and problem-solving programs (Pérez Sánchez & Cabeza, 2007) could be used as facilitators to promote access to information. Easy reading methodology may also be useful (García Muñoz, 2012). Providing young adults with DS with the most appropriate educative support according to their phenotype will help promote their social inclusion and will, therefore, improve their quality of life.

Acknowledgments

We thank the Down Syndrome Foundation of Madrid for its unconditional support. We also thank all the participants with ID who have collaborated in this study and their families. The manuscript was proofread using funds from the Department of Developmental and Educational Psychology, UNED. We would like to use this opportunity to thank the professionals of “Down Madrid” who are always fully involved with each of their students.

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