American Journal on Intellectual and Developmental Disabilities

Emotion word comprehension in Down Syndrome

--Manuscript Draft--

Manuscript Number:	AJIDD-D-20-00114R1
Article Type:	Research Report
Keywords:	Down syndrome; emotional lexicon; vocabulary; developmental trajectories
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Manuscript Region of Origin:	FRANCE
Abstract:	We studied comprehension of emotion versus concrete/abstract words in Down syndrome (DS). Study 1 compared 26 participants with DS and 26 typically developing (TD) children matched on verbal ability. Results showed no difference between groups. Study 2 assessed whether chronological age and (non)verbal abilities predicted developmental trajectories of comprehension in 36 children with DS and 120 TD children. For the latter, these variables predicted comprehension of all three word types. For the former, verbal ability predicted comprehension of all word types, but chronological age and nonverbal ability only predicted comprehension of concrete words. This suggests that individuals with DS have no specific emotional lexicon deficit. Supporting their general lexical development would help them access abstract and emotional meanings.

EMOTION WORD COMPREHENSION IN DOWN SYNDROME

Ethical standards

This study was approved by the academic authorities and all the participants agreed with written consent. The authors assert that all the procedures contributing to this work complied with the ethical standards of the relevant national and institutional committees on human experimentation and with the 1975 Declaration of Helsinki, as revised in 2008. The authors assert that all the procedures contributing to this work complied with the ethical standards of the relevant national and institutional guides on the care and use of laboratory animals.

Abstract

We studied comprehension of emotion versus concrete/abstract words in Down syndrome (DS). Study 1 compared 26 participants with DS and 26 typically developing (TD) children matched on verbal ability. Results showed no difference between groups. Study 2 assessed whether chronological age and (non)verbal abilities predicted developmental trajectories of comprehension in 36 children with DS and 143 TD children. For the latter, these variables predicted comprehension of all three word types. For the former, receptive vocabulary predicted comprehension of all word types, but chronological age and nonverbal reasoning only predicted comprehension of concrete words. This suggests that individuals with DS have no specific emotional lexicon deficit. Supporting their general lexical development would help them access abstract and emotional meanings.

Keywords: Down syndrome, emotional lexicon, vocabulary, developmental trajectories

Introduction

Down syndrome (DS) is the most common genetic cause of intellectual disability. Persons with DS, especially children, are widely described as very warm and sociable, even if this is a rather stereotypical view (Wishart & Johnston, 1990). According to Fidler (2006), young children with DS exhibit relative strengths in early socio-emotional development, but these social strengths do not predict as much success in their subsequent social functioning as might be expected (Fidler et al., 2008). In the middle childhood period, although they have fewer maladaptive behaviors than other pupils with developmental disabilities, children with DS still display more undesirable behaviors than their typically developing (TD) peers (Dykens et al., 2002), which has a negative impact on the way they function at school (Daunhauer et al., 2014; Will et al., 2016). These adaptive difficulties in pupils with DS may be attributed not only to impaired executive functioning (Daunhauer et al., 2014) or motivation (Kasari & Freeman, 2001; Wishart, 2001), but also to reduced emotional competence. Therefore, identifying and better understanding the factors that lead to undesirable behaviors in social contexts is key to promoting academic and social inclusion in DS. The purpose of this study is to examine an important aspect of emotional competence, the comprehension of emotion words, because a deficit in this area may challenge persons with DS' ability to interact effectively with peers and adults and to adopt appropriate behaviors.

Denham (2007) argues that emotional competence plays an essential role in social competence, mental health, and academic success. For this author, three separate components of emotional competence develop during preschool and primary school attendance: experience and regulation of emotions, expression of emotions, and emotion knowledge. The current study focused on this third component, which according to Denham lies "at the heart of emotional competence" (p. 15). *Emotion knowledge* refers to the ability to recognize and name emotions, and to understand the kinds of context or situation in which they are likely to occur. As emphasized by Channell, Conners, and Barth (2014), there is a lack of evidence as to whether children with DS develop these skills enough and are able to use them efficiently. Research on emotion in DS has mainly focused on the ability to recognize facial expressions from photographs (Cebula, Wishart, Willis, & Pitcairn, 2017; Hippolyte, Barisnikov, & Van der Linden, 2008; Hippolyte, Barisnikov, Van der Linden, & Detraux, 2009; Kasari, Freeman, & Hughes, 2001; Pochon & Declercq, 2013, 2014; Williams, Wishart, Pitcairn, & Willis, 2005; Wishart, Cebula, Willis, & Pitcairn, 2007) or from video sequences (Channell et al., 2014; Pochon et al., 2017). Most studies have concluded that persons with DS may have a deficit in the ability to identify the emotional expressions of others (Cebula et al., 2017; Hippolyte et al., 2008, 2009; Kasari et al., 2001; Williams et al., 2005; Wishart et al., 2007), although four studies did not (Channell et al., 2014; Pochon et al., 2017; Pochon & Declercq, 2013; Roch, Pesciarelli, & Leo, 2020). Although these studies involved the understanding of emotional terms (except for Pochon & Declercq, 2013, and Pochon et al., 2017), they did not explore the emotional lexicon per se, despite its potential role in facial expression recognition. This is a very important issue, given the language impairment associated with DS (see Cebula et al., 2017; Pochon & Declercq, 2014). The development of the emotional lexicon in DS is an area of emotional competence that has not so far been sufficiently explored, so the present study was designed to fill this gap in research. As Fidler and Nadel (2007) emphasized, it is important to identify the developmental precursors of relative strengths and weaknesses in DS, in order to design more targeted interventions and avoid unfavorable outcomes.

In the present study, we examined knowledge of words referring to emotions in DS within the more general framework of lexical development, by comparing words referring to emotions with words referring to either concrete or abstract concepts. In psycholinguistics, words referring to emotions have traditionally been likened to abstract words, as opposed to concrete words. Whereas concrete words refer to entities we directly perceive through our senses, abstract words (e.g., *liberty* or *justice*) refer to entities that do not have easily identifiable referents and are more detached from sensory experience. Words denoting emotions have usually been likened to abstract words because they refer to feelings, moods or emotional states (i.e., internal states that are not directly perceptible). Research has repeatedly demonstrated that concrete words have a processing advantage over abstract words, labelled the *concreteness effect*. Concrete words appear to be processed faster and remembered better than abstract words by both adults and children (Fliessbach et al., 2006; Schwanenflugel et al., 1992; Schwanenflugel et al., 1988; Yuille & Paivio, 1969). Moreover, research with children has shown that concrete words are acquired earlier, are easier to learn, and give rise to deeper knowledge than abstract words (Bassano, 2005; Hadley et al., 2016; Paivio & Yuille, 1966; Schwanenflugel & Akin, 1994).

More recently, research has suggested that words for emotions are not exactly identical to abstract words. Experiments have shown that words referring to emotions differ in terms of imageability and concreteness from both abstract and concrete words. For instance, it is easier to visualize a mental image and think of a context for emotion words than for abstract words, but more difficult than for concrete words (Altarriba & Bauer, 2004; Altarriba et al., 1999). Words denoting emotional states, moods or feelings may refer to unobservable entities, but may obviously be matched to internal states that are partly experienced by the senses (McRae & Jones, 2013; Vigliocco et al., 2009). Put differently, words referring to emotions may not be as abstract as other abstract words, as they can be mapped onto the world just as concrete words can.

This idea was recently taken up by researchers studying word meaning acquisition or semantic memory, who distinguish between words according to their mode of acquisition (Borghi et al., 2017; Della Rosa et al., 2010; Kousta et al., 2011; Wauters et al., 2003). According to this approach, word meanings are acquired and represented using information from two sources. The first is the sensory and motor experience of the referents of words in everyday life. The second is linguistic information (i.e., words' verbal associations, co-occurrences in discourse, and syntactic information). The novelty of this approach lies in the assumption that meaning is grounded in both types of information, the precise proportion varying according to the type of concept. Differences between abstract and concrete word meanings therefore arise from the extent to which they are derived from each type of information. Experiential information is preponderant for concrete word meanings, while linguistic information has a greater influence on the acquisition of abstract word meanings. Children start to perceive and experience the world before they acquire language. Consequently, they acquire concrete words earlier than abstract ones. Words denoting emotions are assumed to be associated with experiential information, insofar as they refer to internal states, but also with linguistic information, insofar as their use in language helps children to label these internal states. As such, words for emotions provide a way of accessing abstract meanings, which are mainly conveyed through linguistic channels, but are acquired earlier than purely abstract meanings.

Lexical knowledge in DS has long been assumed to be preserved, compared with expressive language and syntactic abilities (Abbeduto & McDuffie, 2010; Abbeduto et al., 2007; Galeote et al., 2008; Martin et al., 2009). Research suggests that the receptive vocabulary of individuals with DS is consistent with their developmental age, and they are able to derive the meaning of unknown words from context just as readily as TD children matched on developmental age (Jarrold et al., 2009; Roch et al., 2013; Thibaut et al., 2006; Vicari et al., 2000). In addition, their lexical store has been shown to keep on increasing at least until age 20 years (Cuskelly et al., 2016). Several studies have investigated the composition of their receptive vocabulary by analyzing how the proportions of different kinds of words, particularly verbs and nouns, change over the development course (Facon et al., 2012, 2016; Loveall et al., 2016; Polisenska & Kapalkova, 2014).

Most of these studies assessed receptive vocabulary using the most well known standardized measure of lexical development, namely, the Peabody Picture Vocabulary Test (PPVT; Dunn & Dunn, 1981), in which participants are shown four pictures and asked to point to the one corresponding to a word spoken by the examiner. Results did not reveal any differences between participants with DS and TD participants. By contrast, Laws et al. (2014) showed that while receptive vocabulary is a relative strength in individuals with DS, they have a significant deficit in semantic knowledge, compared with TD children. In addition to assessing receptive vocabulary breadth with the PPVT, Laws et al. (2014) examined the depth of semantic knowledge in children with DS, compared with TD children and children with a specific language impairment. To this end, they devised a task inspired by the picture-based semantic association tests used to assess adult patients with semantic dementia. Whereas PPVT results for receptive vocabulary were consistent with previous research, the acquisition of semantic knowledge in children with DS was significantly impaired. This conclusion is consistent with the idea that individuals with DS have greater difficulty understanding abstract vocabulary than concrete vocabulary (Abbeduto et al., 2016; McDuffie et al., 2016).

To investigate the comprehension of words for emotions, we used the experimental task designed by Declercq et al. (2019), based on the PPVT. In this task, the words pronounced by the experimenter refer to either emotions, concrete concepts, or abstract concepts. When Declercq et al. (2019) administered this task to a sample of TD children aged 4-7 years, in addition to highlighting an increase in the comprehension of these three word types across the studied age range, they showed that concrete words are understood better than both emotion and abstract words, and emotion words are understood better than abstract ones. The greatest developmental change concerned abstract words between the ages of 4 and 5 years. As research has evidenced that persons with DS have a deficit in semantic knowledge, and that words for emotions differ from both concrete and abstract words, we hypothesized that words referring to emotions are more difficult to understand than concrete words, but less difficult than abstract words, and that these differences are greater for individuals with DS. We tested these hypotheses in two studies, one adopting a comparative approach, the other a developmental one. Study 1 investigated the understanding of emotional, concrete and abstract words in participants with DS, compared with TD children matched on receptive vocabulary. Study 2 assessed how far chronological age (CA), receptive vocabulary, and nonverbal reasoning predict the developmental trajectories of comprehension for these three word types, in larger samples of participants with DS and TD children.

Study 1

Method

Participants.

We recruited 52 participants: 26 participants with DS (14 girls and 12 boys; mean age = 15.2 years, range = 11.4-20.3) and 26 TD children (13 girls and 13 boys; mean age = 5.2 years, range = 3.6-7.8). The participants with DS were drawn from specialist schools, and the TD children from kindergartens and primary schools. Persons with DS who had sensory disorders or autism spectrum disorder were not included in the study. All the TD children were in mainstream schooling at the expected grade level, and had no psychological, learning, or behavioral disorders. The participants met with the experimenters in a quiet and pleasant room at their school. Each participant with DS was matched with a TD child on lexical level, using the raw scores on the French version of the Peabody Picture Vocabulary Test Revised (EVIP; Thiérault-Whalen & Dunn, 1993). In addition, nonverbal reasoning was assessed by the raw scores on Raven's Colored Progressive Matrices (RCPM; Raven et al., 1988). The characteristics of each group are presented in Table 1.

The present study was conducted with the approval of the academic authorities. Each participant was tested by a licensed psychologist, in compliance with the Code of Ethics for Psychologists, published by the French National Consultative Commission of Ethics for Psychologists. We obtained written informed consent from the parents of all the children who took part in the study. All data were anonymized and confidentiality was respected.

Materials.

The vocabulary task designed by Declercq et al. (2019) consists of 48 words belonging to three categories: 16 words referring to emotions; 16 words referring to abstract concepts; and 16 words referring to concrete concepts. The words referring to emotions belong to the lexical fields of the four basic emotions: happiness, fear, anger, and sadness. For each of these emotions, the authors selected three words, in addition to the target word, based on several criteria. The words' lexical frequency was checked with the MANULEX database (Lété et al., 2004) which is a grade-level lexical database concerning French children.

For each word referring to an emotion, one relevant picture was selected, together with three other pictures illustrating distracting emotions. These images were drawn from the Karolinska Directed Emotional Faces database (Lundqvist et al., 1998). The choice of distractors was based on several criteria. First, fear was not associated with surprise or anger with disgust, as children have difficulty distinguishing between these emotions. Second, each emotion was represented to the same extent as the others.

Pictures representing the words referring to concrete or abstract concepts and the three distractors were drawn from Internet picture databases. Target location was evenly balanced across all the sets. A fixed order of presentation was used for the word types: a concrete word followed by an abstract word, followed by a word referring to an emotion. Within each type, the words were randomly distributed.

Procedure.

Participants were each shown sets of four pictures displayed on a laptop computer monitor (17-inch, 1280 x 1024 pixels) in two rows of two. There were 16 sets for each kind of word (concrete, abstract, and emotion), making a total of 48. Each time a set was displayed on the screen, the children had to point to the correct picture, in response to an instruction that was always formulated in the same way (e.g., “Show me *acrobat*” for a concrete word; “Show me *fantasy*” for an abstract word; “Show me *pleasure*” for an emotion word). Of the 16 French emotion words, four words referred to the concept of happiness (e.g., *joie*, *bonheur*), four to the concept of fear (e.g., *peur*, *crainte*), four to the concept of anger (e.g., *colère*, *rage*), and four to the concept of sadness (e.g., *chagrin*, *malheur*). The preliminary tasks (EVIP and RCPM) were administered in a first session lasting about 15 minutes, and the experimental task in a second session lasting about 20 minutes.

Results

To analyze the data, we began by running an analysis of variance (ANOVA) on the mean numbers of correct choices. Word type (concrete, emotion, abstract) was treated as a within-participants factor, and group (DS, TD) as a between-participants factor. Partial eta-squared (η_p^2) is reported as a measure of effect size. Significant effects were explored with planned orthogonal contrasts. The mean numbers of correct choices according to group and word type are provided in Table 2. We then conducted another ANOVA with only the correct choices for emotion words, to examine whether there were group differences in the identification of individual emotions (Fig. 1). Group was the between-participants factor, and emotion (happiness, fear, anger, and sadness) the within-participants factor. This analysis was followed by Tukey's post hoc test.

Analyses by word type.

The main effect of group was not significant, $F(1, 50) = 0.18$, $p = .67$, $\eta^2 = 0.002$. The mean number of correct choices for participants with DS (*M* = 8.15, *SD* = 3.50) did not differ from that for TD participants (*M* = 8.46, *SD* = 3.26). The main effect of word type was significant, $F(2, 100) = 29.17$, $p < .001$, $\eta^2 = 0.15$. Contrasts showed that the mean number of correct choices was higher for concrete words (*M* = 9.96, *SD* = 3.03) than for emotion or abstract ones (*M* = 7.48, *SD* = 3.03, $p < .001$), and higher for emotion words (*M* = 8.23, *SD* = 2.97) than for abstract ones (*M* = 6.73, *SD* = 2.91, $p < .001$). The interaction between group and word type was not significant, $F(2, 100) = 1.30$, $p = .28$, $\eta^2 = 0.008$.

Analyses by emotion.

As expected, the main effect of group was not significant, $F(1, 50) = 0.01$, $p = .93$, $\eta^2 = .0002$, but there was a significant main effect of emotion, $F(3, 150) = 20.45$, $p < .001$, $\eta^2 = .29$

(see Figure 1). Post hoc comparisons for the effect of emotion indicated that happiness was identified better than sadness, anger and fear (*p*s $< .001$), and fear was identified less than happiness, sadness, and anger (*p*s $< .04$). The Group x Emotion interaction was not significant, $F(3, 150) = 1.63$, $p = .186$, $\eta^2 = .03$. Post hoc comparisons did not reveal any between-group differences, regardless of emotion, but within-group comparisons revealed several differences. In the group with DS, happiness was identified better than sadness and fear (*p*s $< .02$), while in the TD group, happiness was identified better than the other three emotions (*p*s $< .04$), and fear was less well identified than the others (*p*s $< .05$). In sum, results revealed that 1) participants with DS made the same mean number of correct choices as TD participants, 2) both groups had greater difficulty with emotion and abstract words than with concrete words, and with abstract words than with emotion words, and 3) individual emotions were identified at the same level in both groups, with some differences in identification profiles.

Study 2

Method

In this second study, the method was the same as in Study 1, except for the number and age of the participants. Six children and four young adults were added to the group with DS, making a total of 36 participants (16 females and 20 males; age range = 5.0-28.3 years). The TD group comprised the entire sample ($N = 120$, age range = 4–7 years) of Declercq et al. (2019)'s developmental study, with eight additional 3-year-olds, 14 additional 8-year-olds, and one additional 9-year-old, making a total of 143 participants (73 girls and 70 boys; age range = 3.4-9.6 years). For both groups, participants were selected according to the same inclusion criteria as in Study 1 (see Table 3 for the characteristics of each group).

Results

We examined how the comprehension of concrete, abstract and emotional vocabulary develops according to CA, lexical level, as measured by the EVIP raw score, and nonverbal reasoning level, as measured by the raw score on Raven's Colored Progressive Matrices (RCPM; Raven et al., 1988). For each group, we constructed cross-sectional trajectories to examine the onset and rate of acquisition of concrete, abstract and emotion words, following Thomas et al. (2009)'s guidelines. Before constructing trajectories, we ensured that the scores obtained at the preliminary tasks (EVIP and RCPM) in TD group covered the range of scores observed in the group with DS. Then, after including young children and adults with DS, the experimental task sensitivity across the ability range of the group with DS was verified to avoid floor and ceiling effects. Last, Cook's distance (Cook's D) was used to check the influence of outliers on the regression line, no value was identified as a potential outlier, and the goodness-of-fit of different linear and non-linear functions was compared, the linear method was retained for each trajectory.

Comprehension of concrete, abstract and emotion words according to chronological age.

Figures 2a and 2b present the cross-sectional trajectories relating accuracy on the vocabulary task to CA for each group. For the TD group, all three trajectories tended to reach the maximum score at around 10 years. This was not the case for the group with DS, where only the trajectory for concrete words seemed to progress steadily with age. We submitted the accuracy data to a repeated-measures fully factorial analysis of covariance (ANCOVA), with word type (concrete, abstract, and emotion) as the within-participants factor. In the TD group (Fig. 2a), the number of correct choices in the vocabulary task improved significantly with CA, $F(1, 141)$ =

329.75, $p < .001$, $\eta^2 = .70$, and did not differ significantly according to word type, $F(1, 141) = 0.21$, $p = .64$, $\eta^2 = .002$. There was no significant CA x Word type interaction, $F(1, 141) = 1.38$, $p = .24$, $\eta^2 = .01$. For each word type, comprehension improved significantly with CA (concrete: $R^2 = .575$, $p < .001$; abstract: $R^2 = .609$, $p < .001$; emotion: $R^2 = .485$, $p < .001$). In the group with DS (Fig. 2b), the increase in the number of correct choices in the vocabulary task with CA was marginally significant, $F(1, 34) = 3.73$, $p = .06$, $\eta^2 = .099$), and there was no difference according to word type, $F(1, 34) = 1.31$, $p = .26$, $\eta^2 = .037$. However, there was a significant Word type x CA interaction, $F(1, 34) = 4.29$, $p < .05$, $\eta^2 = .112$. Only the number of correct choices for concrete words increased significantly with CA, $R^2 = .191$, $p < .01$. Thus, while comprehension of the three word types progressed in a similar way for TD children, the comprehension of concrete words evolved differently from that of emotion and abstract words for participants with DS.

Comprehension of concrete, abstract and emotion words according to EVIP raw score.

Cross-sectional trajectories relating accuracy on the vocabulary task to the EVIP raw score for the TD and with DS groups are shown in Figures 3a and 3b. For the TD group, trajectories were similar to those observed with CA, whereas in the group with DS, the EVIP score seemed to be a better predictor of accuracy than CA, especially for abstract and emotion words. For the TD group, the EVIP score predicted the number of correct choices in the vocabulary task, $F(1, 141) = 420.88$, $p < .001$, $\eta^2 = .749$, and there was no difference in accuracy according to word type, $F(1, 141) = 0.55$, $p = .461$, $\eta^2 = .004$, and no EVIP score x Word type interaction, $F(1, 141) = 2.62$, $p = .108$, $\eta^2 = .018$. The number of correct choices improved significantly with the EVIP score for each word type (concrete: $R^2 = .663$, $p < .001$; abstract: R^2

= .608, $p < .001$; emotion: $R^2 = .524$, $p < .001$). In the group with DS, the EVIP score was also a significant predictor of performance on the vocabulary task, $F(1, 34) = 63.10$, $p = .001$, $\eta^2 = .65$. There were no differences according to word type, $F(1, 34) = 0.27$, $p = .604$, $\eta^2 = .008$. There was a marginally significant the Word type x EVIP score interaction, $F(1, 34) = 3.13$, $p = .086$, $\eta^2 = .084$. However, for each word type, the number of correct choices improved significantly with the EVIP score (concrete: $R^2 = .619$, $p < .001$; abstract: $R^2 = .469$, $p < .001$; emotion: $R^2 = .524$, $p < .01$). In sum, with the EVIP score as a predictor, we observed mostly similar trajectories for all three word types in both groups. However, although comprehension of all three word types increased with the EVIP score, descriptively, there was greater increase in the group with DS for concrete words, while the trajectories were more similar in the TD group.

Comprehension of concrete, abstract and emotion words according to RCPM raw score.

Figures 4a and 4b show cross-sectional trajectories relating accuracy on the vocabulary task to the RCPM raw score. In the TD group, the profiles of the trajectories were similar to those observed with EVIP, but with less steep slopes, whilst in the group with DS, they were the same as in the CA-based trajectories, with only the concrete trajectory growing steadily with the RCPM score. The number of correct choices in the vocabulary task improved significantly with the RCPM score in the TD group, $F(1, 141) = 129.82$, $p < .001$, $\eta^2 = .479$, and accuracy did not differ according to word type, $F(1, 141) = .89$, $p = .35$, $\eta^2 = .006$. The RCPM score x Word type interaction was not significant, $F(1, 141) = 1.25$, $p = .265$, $\eta^2 = .009$. For each word type, the number of correct choices improved significantly with RCPM score (concrete: $R^2 = .408$, $p < .001$; abstract, $R^2 = .403$, $p < .001$; emotion, $R^2 = .334$, $p < .001$). In the group with DS, there was a significant improvement in correct choices in the vocabulary task with the RCPM score, F(1,

34) = 6.22, $p < .05$, $\eta^2 = .155$, and there was a marginally significant effect of word type, $F(1, 34) = 3.88$, $p = .057$, $\eta^2 = .102$. The Word type x RCPM score interaction effect was significant, $F(1, 34) = 8.65$, $p < .01$, $\eta^2 = .203$. Concrete words were the only category for which comprehension increased significantly with RCPM score, $R^2 = .354$, $p < .001$. Thus, with RCPM as a predictor, the profiles were very similar to those observed when CA was taken as a predictor. Comprehension of the three word types improved in a similar way for TD children. By contrast, an improvement was only observed among participants with DS for concrete words.

Discussion

The current study was designed to investigate the comprehension of emotion words (vs. words referring to concrete or abstract concepts) in persons with DS and TD children. Participants were shown sets of four pictures and asked to choose the picture corresponding to a word pronounced by the experimenter. First, we compared the ability of persons with DS to understand emotion words relative to concrete and abstract words with that of TD children matched on receptive vocabulary (Study 1). Second, we calculated their respective developmental trajectories to assess the development of comprehension of the three word types according to CA, receptive vocabulary, and nonverbal reasoning (Study 2). We expected 1) emotion words to lie at an intermediate level between concrete and abstract words, and 2) the gap between the three word types to be greater for participants with DS.

Overall, the results were consistent with our first hypothesis, as in both groups, responses for emotion words were more accurate than for abstract words, and less accurate than for concrete words, with no differences in word comprehension between participants with DS and TD children. This is consistent with literature findings showing that during childhood, concrete words are acquired earlier and faster than abstract words (Bassano, 2005; Hadley et al., 2016;

Paivio & Yuille, 1966; Schwanenflugel & Akin, 1994). Furthermore, in line with Altarriba and Bauer (2004)'s and Altarriba et al. (1999)'s results, emotion words were found to be easier to understand than abstract words, but harder to understand than concrete words in both groups.

However, the results are only partially consistent with our second hypothesis. On the one hand, when participants with DS and TD children were matched on verbal ability assessed through receptive vocabulary (Study 1), both groups exhibited the same patterns of responses, and there were the same degrees of difference in comprehension between the three word types. This comparative study did not, therefore, confirm our second hypothesis. On the other hand, the developmental study (Study 2) highlighted different developmental trajectories for each word type for participants with DS and TD children. The latter had homogeneous developmental trajectories for all three word types, whether comprehension was predicted by CA, receptive vocabulary, or nonverbal reasoning. In every case, TD children displayed a steady and homogeneous improvement in their comprehension of emotion, concrete and abstract words. Thus, increases for emotional and abstract words were similar to that for concrete words when the word comprehension trajectory was predicted by vocabulary scores (i.e., estimation of linguistic level), by nonverbal reasoning, and by CA. By contrast, two different patterns were observed among participants with DS. The trajectories were homogeneous for all three word types, only showing an improvement when comprehension was predicted by receptive vocabulary. Whereas linguistic level predicted the acquisition of all three word types in participants with DS, CA and nonverbal reasoning only predicted an increase in knowledge for concrete words. For the other two word types, comprehension was not predicted by either CA or nonverbal reasoning. This suggests that the CA-related experience of participants with DS allowed them to learn concrete words, but not abstract or emotional words. This apparent absence of any link between CA and the development of abstract and emotional lexicons is not surprising, given that developmental level is generally a much better predictor than age in intellectual disability. What is important to emphasize in these results is that persons with DS can draw on their experience to acquire new concrete words, despite the developmental delay associated with intellectual disability. More surprising is that nonverbal reasoning (as assessed with RCPM) produced the same developmental pattern as CA in participants with DS, as it predicted the comprehension of concrete words, but not of abstract or emotional words. Nonverbal reasoning does not seem to underpin their access to abstract and emotional meanings, which is not consistent with the idea that vocabulary knowledge tends to correspond to the nonverbal cognitive level in DS (Chapman et al., 2000; Næss et al., 2011, 2015).

These results shed a new light on lexical development suggesting a different developmental trajectory in TD children and in persons with DS. For those participants, the results were consistent with previous studies in which people with DS exhibited greater difficulty understanding abstract versus concrete vocabulary (Abbeduto et al., 2016; McDuffie et al., 2016). In this sense, lexical development seems to follow the same stages in DS as in typical development. This is an important result for persons with DS, as it means that they do not have a specific deficit in the comprehension of words referring to emotions. But our study of developmental trajectories raises questions on the developmental determinants of abstract and emotional lexicon acquisition in DS about which the hypothesis that language abilities contribute to the acquisition of abstract and emotional meaning may provide insight (Borghi et al., 2017; Della Rosa et al., 2010; Kousta et al., 2011; Wauters et al., 2003). According to this hypothesis, linguistic information (i.e.the meaning information that can be extracted from discourse) contributes importantly to the acquisition of emotional and abstract meanings. In other words, information derived from words' verbal associations, co-occurrences in discourse, and syntactic information is supposed to play a crucial role in the acquisition of emotional and abstract meanings.

Indeed, language development is one of the most challenging problem for people with DS. While receptive vocabulary is often considered as a relative strengh, they most often have difficulties with expressive language and with morphosyntax (Abbeduto & McDuffie, 2010; Abbeduto et al., 2007; Galeote et al., 2008; Martin et al., 2009), difficulties that may be associated to verbal short-term memory deficits (Naess, Lyster, Hulme, & Melby-Levag, 2011; Majerus & Barisnikov, 2018). Our data confirms that receptive vocabulary is not systematically a strength in DS. We propose that, if acquiring emotional and abstract meanings relies on linguistic information, limitations in morphosyntax and verbal short-term memory could make their acquisition difficult. In other words, these limitations in morphosyntax and verbal short-term memory could have a ripple effect on words meaning whose acquisition mainly relies on linguistic skills. Interestingly, Channell (2020) drew similar conclusions in a study investigating the mental state language use in children with DS during narrative storytelling. Mental state language is similar to emotional and abstract meanings since its refers to people's emotions, desires, intentions or beliefs. Results indicated that the use of mental state language in children with DS was associated with expressive vocabulary and morphosyntax, and that it was not associated with nonverbal IQ and chronological age. The author concluded that mental state language develops in line with general vocabulary learning and morphosyntactic abilities. Certainly, this study focused on expressive vocabulary while ours focused on receptive vocabulary. Yet, they both highlight the interest of paying attention to the relationships between specific domains of language. Indeed, research in typical development showed that the development of vocabulary and of grammar are intertwined (Labrell et al., 2014). Further studies are necessary to explore these relationships in DS.

We also examined the identification of four basic emotions using verbal labels. Analyses for each individual emotion showed that the participants with DS identified words referring to happiness, sadness, anger, and fear just as well as the TD children. Our results may therefore shed light on the divergent results concerning the ability to recognize facial expressions in DS. While some studies have evidenced a deficit in the ability to identify others' emotional expressions (Cebula et al., 2017; Hippolyte et al., 2008, 2009; Kasari et al., 2001; Williams et al., 2005; Wishart et al., 2007), other studies have failed to find a difference between persons with DS and TD individuals (Barisnikov et al., 2020; Channell et al., 2014; Pochon et al., 2017; Pochon & Declercq, 2013). The idea that this discrepancy may be explained by the role of emotional vocabulary knowledge has been discussed by Pochon and Declercq (2014) and Cebula et al. (2017). There is considerable variability in the way that lexical abilities are taken into account in research on the recognition of emotional expressions in DS. Although the methods used in early studies minimized the use of language and/or controlled for level, they often involved the understanding of emotion labels, which may have put participants with DS at a disadvantage, owing to their substantial language impairment. By specifically studying the emotional lexicon in persons with DS, our study contribute to knowledge about this issue, showing that they have no specific deficit in understanding words referring to emotions such as fear or anger - -emotions that have been problematic for participants with DS in several emotion recognition studies (Cebula et al., 2017; Kasari et al., 2001; Pochon & Declercq, 2014; Williams et al., 2005; Wishart et al., 2007). The fact that vocabulary level was the only predictor of acquisition of the three word types by participants with DS in the present study suggests that their difficulties were related more to general lexical development than to a specific deficit in understanding words referring to emotions.

In this paper, the first study involved matching a group of adolescents with DS with a control group of TD children based on receptive vocabulary. By this experimental design, we obtained several important results showing no difference between the two groups in vocabulary understanding and basic emotion recognition. However, the second study, using a cross-sectional design with developmental trajectories, brought more information about how vocabulary understanding increased with age and other aspects of cognitive domain measures. In particular, this approach produced results showing that the comprehension of abstract and emotion words did not increase with the level of nonverbal reasoning in persons with DS, unlike TD children. This confirms the importance of studying developmental trajectories (Thomas et al., 2009), particularly because this approach is a truly developmental approach (Karmiloff-Smith, 2009). Developmental trajectories allow to draw attention to individual differences that are masked when reporting average group data. Karmiloff-Smith et al. (2016) demonstrated how individual differences are pervasive in DS. They outlined that these individual differences prevent to consider people with DS as a homogeneous group and it is essential to consider them if we want to fully understand DS phenotype.

In several aspects, this paper contributes to delineate the behavioural phenotype of DS. First, it tends to rule out the hypothesis of a syndrome-specific profile of emotion recognition deficits (see Cebula, Moore, & Wishart, 2010) and confirms that emotional difficulties may be related to vocabulary knowledge in individuals with DS. Secondly, it highlights the importance of being attentive to developmental trajectories and of considering how different domains are interconnected during development. More specifically, this paper suggests that difficulties in linguistic skills may have cascading effects on emotional abilities. Our data are important in terms of intervention, as they suggest that the best way of helping persons with DS to access to abstract and emotional meanings is to support their general lexical development, and perhaps language abilities as a whole. The gradual mastery of the emotional lexicon by children and adolescents with DS is key to effectively developing their emotion knowledge, and ultimately enabling them to acquire emotional competence. By understanding and using emotional language, children learn to identify their own emotional states, communicate them to others (Saarni, 2007), and better regulate their emotions in social interactions. It is crucial for preventing emotional problems and maladaptive behaviors in young people with DS (Dykens et al., 2002; Jahromi et al., 2008) and promoting their academic and social inclusion.

References

Abbeduto, L., & McDuffie, A. (2010). Genetic syndromes associated with intellectual disabilities. In C. L. Armstrong, & L. Morrow (Eds.), *Handbook of medical neuropsychology: Applications of cognitive neuroscience* (pp. 193-221). New York: Springer.

Abbeduto, L., McDuffie, A., Thurman, A.J., Kover, S.T. (2016). Chapter three - Language development in individuals with intellectual and developmental disabilities: From phenotypes to treatments. *International Review of Research in Developmental Disabilities*, *50*, 71-118. https://doi.org/10.1016/bs.irrdd.2016.05.006

Abbeduto, L. J., Warren, S. F., & Conners, F. A. (2007). Language development in Down syndrome: From the prelinguistic period to the acquisition of literacy. *Mental Retardation and Developmental Disabilities Research Reviews*, *13*(3), 247-261. https://doi.org/10.1002/mrdd.20158

Altarriba, J., & Bauer, L. M. (2004). The distinctiveness of emotion concepts: A comparison between emotion, abstract, and concrete. *The American Journal of Psychology*, *117*(3), 389‐ 410.

Altarriba, J., Bauer, L. M., & Benvenuto, C. (1999). Concreteness, context availability, and image ability ratings and word associations for abstract, concrete, and emotion words. *Behavior Research Methods, Instruments, and Computers*, *31*(4), 578‐ 602.

Barisnikov, K., Thomasson, M., Stutzmann, J., & Lejeune, F. (2020). The relation between processing facial identity and emotional expression in school-age children and those with Down syndrome. *Applied Neuropsychology: Child*, 9, 179-192. doi:10.1080/21622965.2018.1552867

Bassano, D. (2005). Production naturelle précoce et acquisition du langage. *Lidil*, *31*(1), 14.

Borghi, A. M., Binkofski, F., Castelfranchi, C., Cimatti, F., Scorolli, C., & Tummolini, L. (2017). The challenge of abstract concepts. *Psychological Bulletin*, *143*(3), 263‐ 292.

Cebula, K. R., Moore, D. G., & Wishart J. G. (2010). Social cognition in children with Down's syndrome: challenges to research and theory building. *Journal of Intellectual Disability Research 54*(2), 113‐ 34. doi: 10.1111/j.1365-2788.2009.01215.x.

Cebula, K. R., Wishart, J. G., Willis, D. S., & Pitcairn, T. K. (2017). Emotion recognition in children with Down syndrome: Influence of emotion label and expression intensity. *American Journal of Intellectual Developmental Disabilities*, *122*, 138–155. doi.org/10.1352/1944-7558-122.2.138

Channell, M.M. (2020). Cross-sectional trajectories of mental state language development in children with Down syndrome. American Journal of Speech-Language Pathology, 29, 760-775. https://doi.org/10.1044/2020_AJSLP-19-00035

Channell, M., Conners, F., & Barth, J. (2014). Emotion knowledge in children and adolescents with Down syndrome: A new methodological approach. *American Journal on Intellectual and Developmental Disabilities*, *119*, 405-421. 10.1352/1944-7558-119.5.405.

Chapman, R. S., Seung, H. K., Schwartz, S. E., & Kay-Raining Bird, E. (2000). Predicting language production in children and adolescents with Down syndrome: The role of comprehension. *Journal of Speech, Language, and Hearing Research*, *43*(2), 343–350. https://doi.org/10.1044/jslhr.4302.340

Cuskelly, M., Povey, J., & Jobling, A (2016). The trajectory of development of receptive vocabulary in individuals with Down syndrome. *Journal of Policy and Practice in Intellectual Disabilities, 13*, 111-119.

Daunhauer, L.A., Fidler D.J., & Will E. (2014). School function in students with Down syndrome. *American Journal of Occupational Therapy*, 68, 167-176. doi:10.5014/ajot.2014.009274

Declercq, C., Marlé, P., & Pochon, R. (2019). Emotion comprehension in children aged 4-7 years. *The Educational and Developmental Psychologist*, *36*, 82-87.

Della Rosa, P. A., Catricalà, E., Vigliocco, G., & Cappa, S. F. (2010). Beyond the abstract-concrete dichotomy: Mode of acquisition, concreteness, imageability, familiarity, age of acquisition, context availability and abstractness norms for a set of 417 Italian words. *Behavior Research Methods*, *42*(4), 1042‐ 1048.

Denham, S. A. (2007). Dealing with feelings: How children negotiate the worlds of emotions and social relationships. *Cognition, Brain, Behavior*, *11*(1), 1–48.

Dunn, L., M., & Dunn, L., M. (1981). *Peabody Picture Vocabulary Test-Revised*. Circle Pines, MN: American Guidance Service.

Dunn, L., M., Thériault-Whalen, C., M., & Dunn, L., M. (1993). *Échelle de vocabulaire en images Peabody (EVIP) [Peabody Picture Vocabulary Test – Revised]*. Toronto, ON: Psycan.

Facon, B., Courbois, Y., & Magis, D. (2016). A cross-sectional analysis of developmental trajectories of vocabulary comprehension among children and adolescents with Down syndrome or intellectual disability of undifferentiated aetiology. *Journal of Intellectual and Developmental Disability*, *41*, 140-149.

Facon, B., Nuchadee, M.-L., & Bollengier, T. (2012). A qualitative analysis of general receptive vocabulary of adolescents with Down syndrome. *American Journal on Mental*

Retardation / American Journal on Intellectual and Developmental Disabilities, *117*, 243-259.

Fidler, D. J. (2006). The emergence of a syndrome-specific personality profile in young children with Down syndrome. *Down Syndrome Research and Practice*, *10*(2), 53-60. doi:10.3104/reprints.305

Fidler, D. J., Most, D. E., Booth-LaForce, C., & Kelly, J. F. (2008). Emerging social strengths in young children with Down syndrome. *Infants & Young Children*, *21*, 207-220. doi:10.1097/01.IYC.0000324550.39446

Fidler, D. J., & Nadel, L. (2007). Education and children with Down syndrome: Neuroscience, development, and intervention. *Mental Retardation and Developmental Disabilities Research Reviews*, *13*, 262-271. https://doi.org/10.1002/mrdd.20166

Fliessbach, K., Weis, S., Klaver, P., Elger, C. E., & Weber, B. (2006). The effect of word concreteness on recognition memory. *NeuroImage*, *32*, 1413‐ 1421. https://doi.org/10.1016/j.neuroimage.2006.06.007

Galeote, M., Sebastián, E., Checa, E., Rey, R., & Soto, P. (2011). The development of vocabulary in Spanish children with Down syndrome: Comprehension, production and gestures. *Journal of Intellectual & Developmental Disability*, *36*(3), 184-196.

Hadley, E. B., Dickinson, D. K., Hirsh-Pasek, K., & Nesbitt, K. T. (2016). Examining the acquisition of vocabulary knowledge depth among preschool students. *Reading Research Quarterly*, *51*(2), 181‐ 198. https://doi.org/10.1002/rrq.130

Hippolyte, L., Barisnikov, K., & Van der Linden, M. (2008). Face processing and facial emotion recognition in adults with Down syndrome. *American Journal on Mental Retardation*, *11*, 292–306.

Hippolyte, L., Barisnikov, K., Van der Linden, M., & Detraux, J.-J. (2009). From facial emotional recognition abilities to emotional attribution: A study in Down syndrome. *Research in Developmental Disabilities*, *30*, 1007-1022. https://doi.org/10.1016/j.ridd.2009.02.004

Jahromi, L. B., Gulsrud, A., & Kasari, C. (2008). Emotional competence in children with Down syndrome: Negativity and regulation. *American Journal of Mental Retardation*, *113*, 32-43.

Jarrold, C., Thorn, A. S. C., & Stephens, E. (2009). The relationships among verbal short-term memory, phonological awareness, and new word learning: Evidence from typical development and Down syndrome. *Journal of Experimental Child Psychology*, *102*, 196-218. https://doi.org/10.1016/j.jecp.2008.07.001

Karmiloff-Smith, A. (2009). Nativism versus neuroconstructivism: rethinking the study of developmental disorders. *Developmental psychology, 45*(1), 56–63. https://doi.org/10.1037/a0014506

Kasari, C., & Freeman, S. F. (2001). Task-related social behavior in children with Down syndrome. *American Journal of Mental Retardation*, *106*, 253-264. doi:10.1352/0895-8017(2001)106

Kasari, C., Freeman, S. F. N., & Hughes, M. A. (2001). Emotion recognition by children with Down syndrome. *American Journal on Mental Retardation*, *106*, 59–72.

Kousta, S.-T., Vigliocco, G., Vinson, D. P., Andrews, M., & Del Campo, E. (2011). The representation of abstract words: Why emotion matters. *Journal of Experimental Psychology: General*, *140*(1), 14‐ 34. https://doi.org/10.1037/a0021446

Labrell, F., Van Geert, P., Declercq, C., Baltazart, V., Caillies, S., Olivier, M., Le Sourn-

Bissaoui, S. (2014). "Speaking volumes": a longitudinal study of lexical and grammatical growth between 17 and 45 months. *First Language, 34(2),* 97-124.

Laws, G., Briscoe, J., Ang, S.-Y., Brown, H., Hermena, E., & Kapikian, A. (2015). Receptive vocabulary and semantic knowledge in children with SLI and children with Down syndrome. *Child Neuropsychology*, *21*, 490-508. doi:10.1080/09297049.2014.917619

Lété, B., Sprenger-Charolles, L., & Colé, P. (2004). MANULEX: A grade-level lexical database from French elementary-school readers. *Behavior Research Methods, Instruments, & Computers*, *36*, 156-166.

Loveall, S. J., Channell, M. M., Phillips, B. A., Abbeduto, L. J., & Conners, F. A. (2016). Receptive vocabulary analysis in Down syndrome. *Research in Developmental Disabilities*, *55*, 161-172. https://doi.org/10.1016/j.ridd.2016.03.018

Lundqvist, D., Flykt, A., & Öhman, A. (1998). *The Karolinska Directed Emotional Faces—KDEF* [CD-ROM]. Department of Clinical Neuroscience, Psychology section, Karolinska Institutet, Stockholm, Sweden.

Majerus, S., and Barisnikov, K. (2018) Verbal short-term memory shows a specific association with receptive but not productive vocabulary measures in Down syndrome. *Journal of Intellectual Disability Research*, 62: 10– 20. doi: 10.1111/jir.12443.

Martin, G. E., Klusek, J., Estigarribia, B., & Roberts, J.E. (2009). Language characteristics of individuals with Down syndrome. *Topics in Language Disorders*, *29,* 112-132. doi:10.1097/tld.0b013e3181a71fe1

McDuffie, A., Thurman, A. J., Channell, M. M., & Abbeduto, L. (2017). Language disorders in children with intellectual disability of genetic origin. In R. Schwartz (Ed.), *Handbook of child language disorders* (2nd ed., pp. 52–81). New York: Taylor & Francis.

McRae, K., & Jones, M. (2013). Semantic memory. In D. Reisberg (Ed.), *The Oxford handbook of cognitive psychology* (pp. 232‑ 239). https://doi.org/10.1093/oxfordhb/9780195376746.001.0001

Næss, K. B., Lervåg, A., Halaas Lyster, S.-A., & Hulme, C. (2015). Longitudinal relationships between language and verbal short-term memory skills in children with Down syndrome. *Journal of Experimental Child Psychology*, *135*, 43-55. https://doi.org/10.1016/j.jecp.2015.02.004

Næss, K.-A., Lyster, S.-A. H., Hulme, C., & Melby-Lervaˆ g, M. (2011). Language and memory skills in children with Down syndrome: A meta-analytic review. *Research in Developmental Disabilities, 32,* 2225-2234.

Paivio, A., & Yuille, J. C. (1966). Word abstractness and meaningfulness and paired-associate learning in children. *Journal of Experimental Child Psychology*, *4*, 81‑ 89.

Pochon, R., & Declercq, C. (2013). Emotion recognition by children with Down syndrome: A longitudinal study. *Journal of Intellectual and Developmental Disability*, *38*(4), 332-343.

Pochon, R., & Declercq, C. (2014). Emotional lexicon understanding and emotion recognition: A longitudinal study in children with Down syndrome. *Journal of Physical and Developmental Disabilities*, *26*, 549-563.

Pochon, R., Touchet, C., & Ibernon, L. (2017). Emotion recognition in adolescents with Down syndrome: A nonverbal approach. *Brain Sciences*, *7*, 55.

Polišenská, K., & Kapalková, S. (2014). Language profiles in children with Down syndrome and children with language impairment: Implications for early intervention. *Research in Developmental Disabilities*, *35*, 373-382. https://doi.org/10.1016/j.ridd.2013.11.022

Raven, J.C., Court, J.H., & Raven, J. (1998). *Progressive matrices couleur/Colored progressive matrices*. Paris : Les Editions du Centre de Psychologie Appliquée.

Roch, M., Florit, E., & Levorato, C. (2013). The role of linguistic context in deriving word meanings in individuals with Down syndrome. *Research in Developmental Disabilities*, *34*, 605-615. https://doi.org/10.1016/j.ridd.2012.09.014

Roch M., Pesciarelli F. & Leo I. (2020). How individuals with Down syndrome process faces and words conveying emotions? Evidence from a priming paradigm. *Frontiers in Psychology, 1, 692*. doi: 10.3389/fpsyg.2020.00692

Saarni, C. (2007). The development of emotional competence: Pathways for helping children to become emotionally intelligent. In R. Bar-On, J. G. Maree, & M. J. Elias (Eds.), *Educating people to be emotionally intelligent* (pp. 15‐ 35). Westport, CT: Praeger Publishers/Greenwood Publishing Group.

Schwanenflugel, P. J., & Akin, C. E. (1994). Developmental trends in lexical decisions for abstract and concrete words. *Reading Research Quarterly*, *29*(3), 250‐ 264. https://doi.org/10.2307/747876

Schwanenflugel, P. J., Akin, C., & Luh, W.-M. (1992). Context availability and the recall of abstract and concrete words. *Memory and Cognition*, *20*(1), 96‐ 104. https://doi.org/10.3758/BF03208259

Schwanenflugel, P. J., Harnishfeger, K., & Stowe, R. (1988). Context availability and lexical decisions for abstract and concrete words. *Journal of Memory and Language*, *27*, 499‐ 520.

Thibaut, J.-P., Elbouz, M., & Comblain, A. (2006). Apprentissage, mémorisation, et généralisation de nouveaux noms chez l'enfant trisomique 21. Une comparaison avec l'enfant en développement normal. *Psychologie Française*, *598*, 377-480. http://dx.doi.org/10.1016/j.psfr.2006.05.005

Thomas, M. S. C., Annaz, D., Ansari, D., Serif, G., Jarrold, C., & Karmiloff-Smith, A. (2009). Using developmental trajectories to understand developmental disorders. *Journal of Speech, Language, and Hearing Research*, *52*, 336-358.

Vicari, S., Caselli, M.C., & Tonucci, F. (2000). Asynchrony of lexical and morphosyntactic development in children with Down syndrome. *Neuropsychologia*, *38*, 634-644. https://doi.org/10.1016/S0028-3932(99)00110-4

Vigliocco, G., Meteyard, L., Andrews, M., & Kousta, S. (2009). Toward a theory of semantic representation. *Language and Cognition*, *1‐ 2*, 219‐ 247.

Wauters, L. N., Tellings, A., Van Bon, W. H. J., & Van Haaften, A. W. (2003). Mode of acquisition of word meanings: The viability of a theoretical construct. *Applied Psycholinguistics*, *24*, 385‐ 406. https://doi.org/10.1017/S0142716403000201

Will, E. A., Gerlach-McDonald, B., Fidler, D. J., & Daunhauer, L. A. (2016). Impact of maladaptive behavior on school function in Down syndrome. *Research in Developmental Disabilities*, *59*, 328-337.

Williams, K. R., Wishart, J. G., Pitcairn, T. K., & Willis, D. S. (2005). Emotion recognition in children with Down's syndrome: Investigation of a specific impairment. *American Journal on Mental Retardation*, *110*, 378–392.

Wishart, J. (2001). Motivation and learning styles in young children with Down syndrome. *Down's Syndrome, Research and Practice*, *7*, 47-51.

Wishart, J. G., Cebula, K. R., Willis, D. S., & Pitcairn, T. K. (2007). Understanding of facial expressions of emotion by children with intellectual disabilities of differing aetiology.

Journal of Intellectual Disability Research, *51*, 551–563. doi:10.1111/j.1365-2788.2006.00947.x

Wishart, J. G., & Johnston, F. H. (1990). The effects of experience on attribution of a stereotyped personality to children with Down's syndrome. *Journal of Mental Deficency Research*, *34*, 409-420. doi:10.1111/j.1365-2788.1990.tb01551.x

Wishart, J. G., & Pitcairn, T. K. (2000). Recognition of identity and expression in faces by children with Down syndrome. *American Journal on Mental Retardation*, *105*, 466–479. doi:10.1352/0895-8017(2000)105<0466:ROIAEI>2.0.CO;2

Yuille, J. C., & Paivio, A. (1969). Abstractness and recall of connected discourse. *Journal of Experimental Psychology*, *82*(3), 467‐471.

Table 1
Characteristics of EVIP-Matched Groups

	Group				
	With Down syndrome (*n* = 26)		Typically developing (*n* = 26)		
Variables	Mean	*SD*	Mean	*SD*	*t* value
Chronological age (months)	182.65	32.49	62.61	14.51	17.20***
EVIP raw score	56.35	24.96	56.54	24.74	0.87
RCPM raw score	16.73	5.63	15.42	5.15	-0.03

Note. Ages reported in months. EVIP: Peabody Picture Vocabulary Test Revised; RCPM: Raven's Progressive Colored Matrices. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table 2
Mean (Standard Deviation) Numbers of Correct Choices According to Word Type and Group

	Group			
	With Down syndrome (*n* = 26)		Typically developing (*n* = 26)	
	Mean	*SD*	Mean	*SD*
Concrete	10.08	3.28	9.85	3.09
Emotion	8.19	3.39	8.27	2.76
Abstract	6.19	2.84	7.27	3.53

Table 3
Characteristics of Developmental Groups

	Group			
	With Down syndrome (*n* = 36)		Typically developing (*n* = 143)	
Variables	Mean	*SD*	Mean	*SD*
Chronological age (months)	179.14	60.62	73.22	17.38
EVIP raw score	52.30	24.78	74.47	25.62
RCPM raw score	16.67	5.40	20.29	6.13

Note. . Ages reported in months. EVIP: Peabody Picture Vocabulary Test Revised; RCPM: Raven's Progressive Colored Matrices.

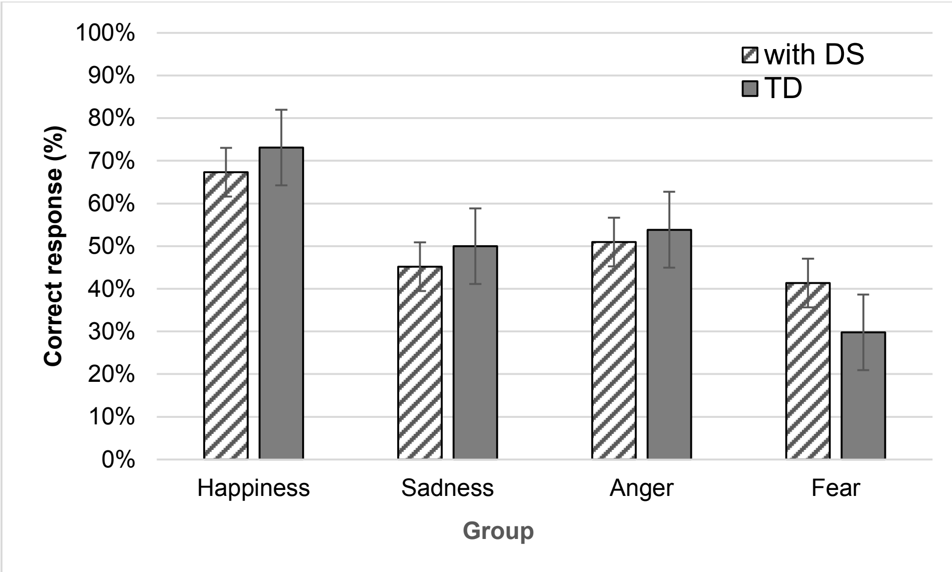

Figure 1. Mean percentage of correct responses for the four emotions in EVIP-Matched Groups (*n* = 26).

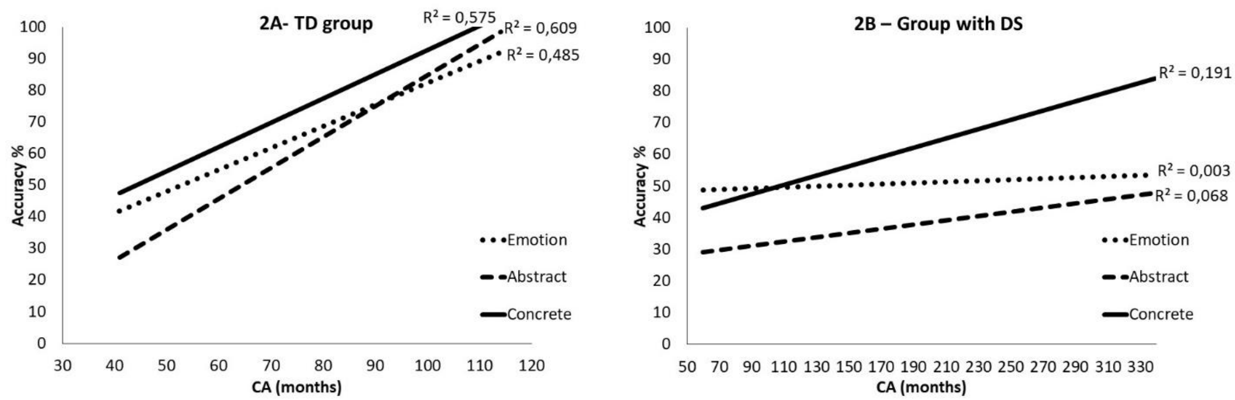

Figure 2. Cross-sectional trajectories of accuracy scores on the vocabulary task for each group plotted against chronological age.

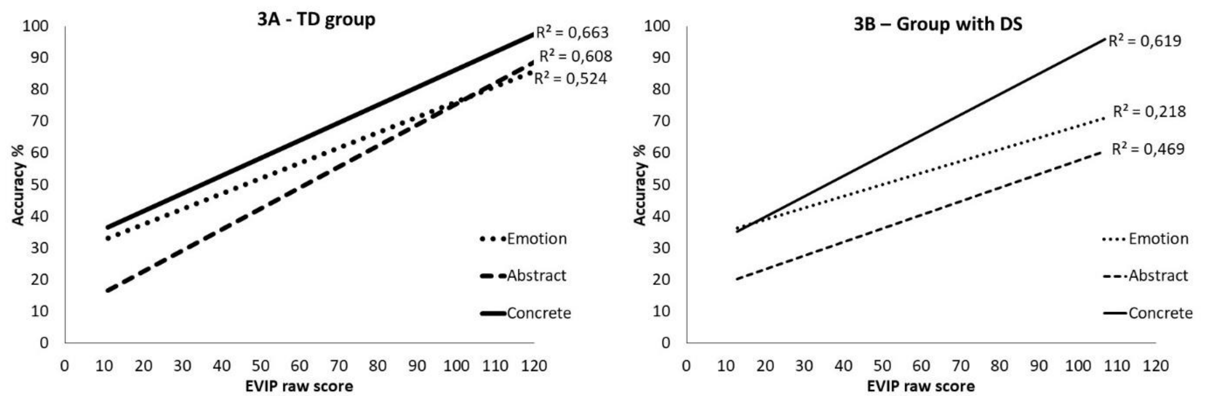

Figure 3. Cross-sectional trajectories of accuracy scores on the vocabulary task for each group plotted against EVIP raw score.

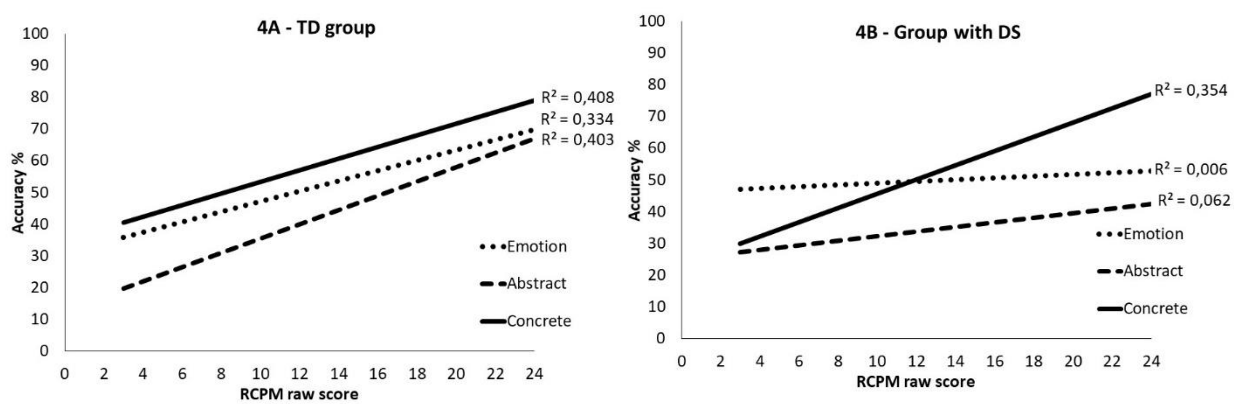

Figure 4. Cross-sectional trajectories of accuracy scores on the vocabulary task for each group plotted against RCPM raw score.