

How individuals with Down syndrome understand ambiguous quantifiers

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Abstract

Individuals with Down syndrome (IDS) display difficulties in understanding quantifiers but also in dealing with small numerosities. To allow for a better understanding of what may underlie these difficulties, we examined how IDS interpret the German quantifier *eine* ('a/one'). This expression is ambiguous as it can refer to the exact numerosity of 'one' but also serves as the indefinite determiner 'a'. We found that IDS were able to derive a lower-bounded interpretation of *eine* but not yet an upper-bounded interpretation. Like typically-developing children, IDS often accepted two tokens as a correct instance of *eine*, suggesting that IDS's answer did not differ qualitatively from typically developing children but rather that ambiguities in language contribute to difficulties in how IDS interpret quantifiers.

Keywords: Down syndrome, quantifiers, numerosity, atypical language development

Introduction

It has been shown that individuals with Down syndrome (henceforth IDS) have difficulties in understanding and producing language (e.g., Chapman Hesketh, 2001). Additionally, IDS encounter difficulties when it comes to numerical abilities such as counting and estimating numbers (e.g., Nye et al., 2001). These observations beg the question of how IDS come to understand quantifiers (like *many*, *all*, or *some*), since interpreting these expressions requires both linguistic and numerical abilities. However, apart from a few exceptions (Dolscheid & Penke, 2018), little is known about how quantifiers are acquired by IDS. In the present study, we seek to contribute to this issue by illuminating how IDS come to understand the German quantifier *eine* ('a/one'). This term is ambiguous as it is used as a numeral to refer to the exact quantity of 'one' but at the same time it also serves as the indefinite determiner 'a' (as in 'a house', 'a strawberry', etc.). Previous research has shown that typically-developing German-speaking children (TD) differ from adults in that they do not yet understand *eine* in an upper bounded, exact way (Dolscheid et al., 2019). That is, when asked whether there is *eine* (a/one) strawberry in a bowl, most children confirm this question even when presented with two strawberries (Dolscheid et al., 2019). By contrast, most adult speakers of German do not accept two

strawberries as a correct instance of *eine*, suggesting they interpret this term as exactly one (but not more). However, when presented with exactly one strawberry, TD children already correctly accept *eine* and they also correctly reject *eine* when no strawberry is presented, thus showing a lower-bounded interpretation. Since IDS have been shown to display problems with understanding quantifiers in general (e.g., Dolscheid & Penke, 2018) but also in dealing with small numerosities in particular (Abreu-Mendoza et al., 2020), this raises the question of how IDS come to understand the quantifier *eine*. Specifically, we can examine which aspects of this quantifier may lead to potential difficulties: Thus, do IDS already interpret *eine* in a lower-bounded fashion (as non-zero)? Can they correctly infer that *eine* refers to the quantity of one? And do they interpret *eine* in an exact, upper-bounded way or do they rather follow TD children’s interpretation in that they also accept two tokens as a correct response to *eine*? To address these open questions, we examined how German-speaking IDS interpret *eine* in a truth-value-judgement task (TVJT) and compared their performance to cohorts of TD children and adult speakers of German (based on Dolscheid et al., 2019).

Methodology

Participants

36 German-speaking IDS were examined (mean chronological age: 13;09 years, 19 female). The data of one participant had to be excluded because the participant was unable to perform the task properly (i.e., the response was always ‘yes’, regardless of the question being asked). Nonverbal mental age of the participants with DS was assessed by using the SON-R 2.5-7 (Tellegen et al., 2007). Mental age ranged from 3;02 to 7;11 years (M 4;10) and was comparable to the chronological age of 37 monolingual TD children previously examined by Dolscheid and colleagues (2019): age range: 2;11 – 6;11 years (M 4;09). Additionally, we compared performance of IDS to that of adult speakers of German as reported in Dolscheid and colleagues (2019).

Procedure

IDS participated in a truth-value-judgment task (TVJT). Stimuli consisted of a white plastic bowl and three different kinds of small plastic fruits, presented in separate piles (i.e., 8 strawberries, 8 oranges, and 8 bananas). To ensure that IDS could distinguish the different fruit types, the experimenter first pointed to an exemplar of each kind and asked participants to identify the different fruit types. As soon as participants demonstrated knowledge of each fruit type, the experimenter explained the task to the participant. Subsequently, the experimenter moved a certain number of strawberries into the bowl and asked the participant a Yes/No question using the quantifier *eine* (‘a/one’). In the trials that are critical for the current purpose, IDS were either presented with

no strawberry, exactly one strawberry, or two strawberries while being asked ‘Is there *eine* (‘a/one’) strawberry in the bowl?’. After each trial, the experimenter returned the fruit tokens to their original piles.

Results

Like TD children and adult speakers of German, 100% of the IDS correctly rejected the claim that there was *eine* (a/one) strawberry in the bowl when in fact there was none. Furthermore, 100% of the IDS correctly accepted that there was *eine* strawberry in the bowl when presented with exactly one token of a strawberry. When asked for *eine* (a/one) strawberry in the context of two strawberries, 83% of the IDS accepted this claim, thus showing no upper-bounded interpretation of *eine*. Conversely, 17% rejected two strawberries as a correct instance of *eine*. When directly comparing IDS’s performance to that of typically developing children and adult speakers of German (see Figure 1, for a comparison of the results), a logistic regression revealed that IDS significantly differed from adults in terms of their upper-bounded interpretation of *eine* (z -ratio = -3.924, $p < 0.001$). Unlike adults who predominantly rejected two strawberries as a correct instance of *eine* (68% rejections), the same did not apply to IDS. By contrast, IDS’s interpretation of *eine* was comparable to that of TD children (11% rejections), and there was no significant difference between the two groups in a logistic regression (z -ratio = -0.72, $p = 0.72$).

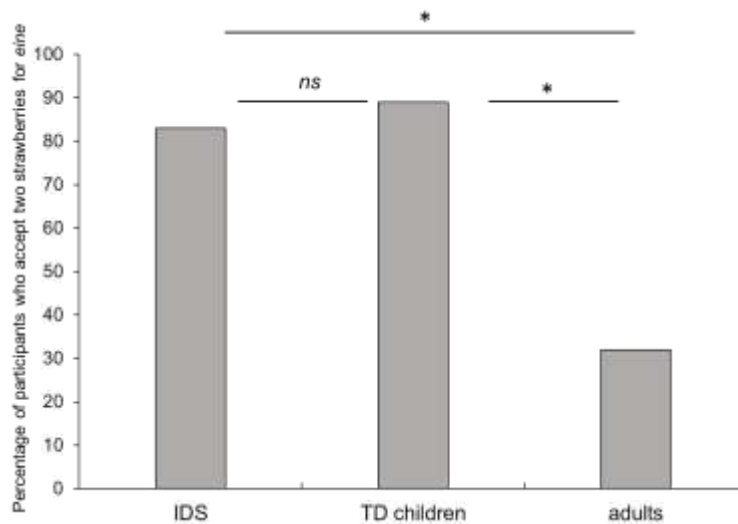


Figure 1. Comparison of the different groups (Percentage of participants who accept two strawberries as a correct response to *eine* (a/one)). Data of TD children and adults were extracted from Dolscheid et al. (2019).

Discussion

While previous research has shown that IDS display difficulties in quantifier comprehension (e.g., Dolscheid & Penke, 2018), in the present study, we sought to better characterize the nature of these difficulties by focusing on the ambiguous quantifier *eine*. Overall, we found that IDS understand this quantifier in a way that is comparable to TD children. Specifically, IDS interpret *eine* as lower-bounded (not zero) and display equal knowledge that *eine* refers to the quantity of one. However, IDS do not yet show an upper-bounded interpretation of *eine* since the majority of IDS accepts two strawberries as a correct response to *eine*. Yet, the same is true for TD children, suggesting that IDS do not critically deviate from TD children in their interpretation of *eine*. Rather, ambiguities in language seem to lead to the observed patterns of interpretation. Since in German *eine* serves two functions in that it might be used as the exact numeral but also as the indefinite determiner, this ambiguity seems to foster a vague, non-exact interpretation in TD children as well as in IDS. While future work is necessary to pin down the exact contributions of mathematical and linguistic abilities for IDS's understanding of numerosity, our findings demonstrate that ambiguities in language contribute to IDS's non-exact interpretation of *eine*, hence providing a challenge for number acquisition.

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