Early categorization abilities in young children with Williams syndrome

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The present study investigated whether 2- to 6-year-old children with Williams syndrome can form new object categories based on either visual or verbal information alone. Children were presented with six triads of objects. In each triad, two objects either shared visual properties, or were given the same name. Following the presentation of each triad, categorization based on the shared visual or verbal property was evaluated through object manipulation. While the children categorized the objects according to visual cues, they failed to use the verbal cues. These results contrast with previous research showing that typically developing toddlers, who were much younger than the children with WS and much less advanced in their vocabulary development, could perform both types of categorization. The present study hence supports the claim that vocabulary acquisition in Williams syndrome develops atypically. *NeuroReport* 13:1–4 © 2002 Lippincott Williams & Wilkins.

Key words: Language acquisition; Lexical/vocabulary development; Object categorization; Williams syndrome

INTRODUCTION

Lexical or vocabulary acquisition is a multi-faceted task requiring three basic skills: (i) the representation of the sound patterns of words, (ii) the building of concepts for objects and events in the world, and (iii) the mapping of each sound pattern to the particular concept it stands for. Typically, infants have begun mastering these requirements by their first birthday, as attested by the onset of word comprehension around 10 months, and of word production by 12 months [1–3]. Lexical acquisition accelerates around 18 months of age, a phenomenon sometimes called the vocabulary spurt that is linked to various developments at the cognitive level and signals that the mechanisms for lexical acquisition are changing or becoming more efficient [4–6]. Does this typical developmental trajectory hold for children with Williams syndrome?

Williams syndrome is a rare genetic disorder (1 in 20 000 live births) [7,8] caused by a hemizygous sub-microscopic deletion of some 18–20 contiguous genes on chromosome 7q11,23 [9,10]. At the clinical level, individuals with Williams syndrome can be recognized by their specific elfin-like face and various physical anomalies including feeding and heart problems [11]. At the cognitive level, they can be identified by their characteristic uneven profile (for an IQ generally in the 50–65 range). Even though many non-linguistic functions, such as spatial cognition, number, planning and problem solving are severely impaired, some aspects of language performance, face processing and social interaction are relatively proficient [12–14].

However, although language is a relative strength in Williams syndrome, its onset is severely delayed in early childhood [15,16], suggesting problems in mastering the basic skills involved in lexical acquisition. Several studies have investigated the possible origins of these developmental problems. One study on early speech perception found that 1–4 year olds with Williams syndrome have difficulties in segmenting words, that is isolating individual words from a flow of speech, an ability already present at 10.5 months in typically developing infants [17]. Other studies on later lexical development have failed to replicate some of the relationships between linguistic and cognitive milestones found in typical development. For example, infants with Williams syndrome start naming objects before, rather than after, starting to point at them [18,19]. The delayed vocabulary spurt precedes by up to 12 months, rather than follows, the emergence of various cognitive abilities (including categorization abilities) typically involved in lexical acquisition [4,5,20]. Finally, young adults with Williams syndrome have problems using some of the cognitive biases normally constraining the acquisition of words [21].

By showing that lexical acquisition significantly precedes the onset of the cognitive abilities with which it is normally associated, the above studies suggest that lexical development in Williams syndrome is not just delayed, but might actually follow an atypical developmental trajectory [22]. In this context, the link between vocabulary development and the emergence of name-based categorization found for

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typical development [23] might not hold for Williams syndrome. This link was established for normal development in a study showing that 20-month-old infants, but not 16-month-old infants, can categorize together two dissimilar-looking objects provided they are given the same name. The emergence of this ability appeared to be linked to vocabulary growth, as suggested by the fact that: (a) at 20 months, name-based categorization (but not visual-based categorization) was correlated with vocabulary size, and (b) the 20-month-olds had larger vocabularies (141 words) than the 16-month-olds (28 words). Hence, these findings suggest that early during development (by 20 months and 141 words in average), names given to objects are used by children as a strong indication of the conceptual categories to which they belong.

In the present study, we replicate the above study carried out with normal children to determine whether children with Williams syndrome can categorize objects based on visual and/or verbal cues, and whether, as found for other developmental links, vocabulary development will again precede cognitive changes in this clinical population. The same object manipulation task is used in both conditions (in order to allow comparisons of their use). In both conditions, children are presented with triads of unfamiliar objects (three trials per condition). In the visual condition, two of the objects are perceptually identical, and no labels are provided. In the naming condition, the objects are visually unrelated, they are all labeled, and two of them receive the same label. Children's pairings of the two objects that either looked the same or had received the same label are taken as evidence of their use of naming and/or visual cues to form object categories.

MATERIALS AND METHODS

Participants: Twelve children with Williams syndrome (seven males, five females) from monolingual English-speaking American families were recruited at the US Conference on Williams syndrome, Dearborn, MI. Their mean age was 4 years, 8 months, 26 days (range 2 years, 9 months, 6 days to 6 years, 10 months, 0 days). Eight of children were in their fifth year.

Materials: Six triads of small objects were used during the testing session. All objects were selected so that the infants would be unfamiliar with them and would not already have a name for them. The three visual sets were made up of a pair of identical objects and a third object that differed from the other two in shape, color, and texture. The three naming sets were made up of three very distinct objects, that all differed in shape, color, and texture in an effort to equalize their perceptual distance.

Procedure: The procedure was identical to that used previously [23], with the exception of the addition of a final visual trial (see below). Children were tested individually for 10 min in a quiet room, in the presence of a caregiver.

After an informal warm-up period, the child was seated on a chair across a table from the experimenter, and the testing session started. It comprised seven trials: a block of three visual trials (using the visual sets), a block of three naming trials (using the naming sets), and finally a repetition of the first visual trial. The visual trials tested for categorization based on visual properties, while the naming trials tested for categorization based on naming, with the final visual trial used to be sure that children continued to concentrate on the task.

Each trial was composed of a presentation phase, followed by a categorization question. Each trial started with the presentation of the three objects, one at a time. The child was encouraged to manipulate each object for a few seconds, before placing it on the table. Within each trial, the objects were arranged on the table on a left-to-right sequence (child's perspective) in order to minimize memory load. The experimenter spoke while presenting each object, saying for the visual/naming trials: ''Look! Look at this one./A tib. This is a tib. Do you want to play with this one/the tib? Yes, play with this one/the tib. See this one/the tib? All right, let's put this one/the tib on the table. Here.'' On naming trials, each object was named exactly six times. We used two non-words, tib and dap, in counterbalanced order.

After the presentation phase, the experimenter tested categorization by putting one object of the visual or named pair in his own hand, placed at equal distance from the remaining two objects, and asking the child to give him ''the object that goes with this one''. While waiting for the response, the experimenter looked at either the child's face or the object in his hand in order to avoid influencing the child's response. After the child's response, positive feedback was provided regardless of the choice made. Successful performance corresponded to the selection of the visually matching object in the visual trials, and the similarly labeled object in the naming trials. The order of presentation of the trials within each block, the position of the paired objects on the table, the side of the object picked up by the experimenter, and the pairs defined by the names in the naming trials were counterbalanced across participants.

Finally, the MacArthur Communicative Development Inventory: Toddlers (CDI) [24] was used to determine the size of the child's productive vocabulary. The CDI is a 705 word inventory of early produced words (subdivided into various subclasses of words, such as animals, food, vehicles, etc.), which has been normalized for typical development. Parents are asked to check the words that their child says spontaneously (mispronounced words are included in the count); the total number of checked words gives an estimate of overall productive vocabulary size.

RESULTS

CDI vocabulary measures: The children with Williams syndrome had a mean ($\pm$ s.d.) productive vocabulary of 504 ± 234 words (range 68–704). Half of the children were at ceiling on the CDI (> 655 words out of a total of 705 words). Overall, the productive vocabulary of our participants was much larger than that of the 16- and 20-month-old children studied previously [23], who had 28 and 141 words respectively.

Categorization measures: In both conditions, children were given, for each trial, a score of 1 when the object chosen was the second of the (visual or named) pair, and a score of 0 otherwise (see Table 1 and Table 2 for individual

Table 1. Age, number of correct responses in the visual and naming condition, performance on the final visual trial, and size of productive vocabulary for all 12 children with Williams syndrome.

Subject	Age (months)	Visual	Naming	Final visual	No. words
1	33	3	2	yes	122
2	46	3	0	yes	327
3	50	2	1	yes	413
4	53	3	1	yes	607
5	56	2	2	yes	68
6	57	1	2	no	659
7	57	3	1	yes	662
8	59	3	1	yes	391
9	59	3	1	yes	688
10	60	3	3	yes	704
11	72	3	2	yes	704
12	82	3	1	yes	704

Table 2. Mean ($\pm$s.d.) numbers of correct responses in the visual and naming conditions for the children with Williams syndrome (present study), compared to 16- and 20-month-old children with normal development (from [23]).

	Williams	16-month-olds	20-month-olds
Visual	2.67 ± 0.65**	2.29 ± 0.75**	2.54 ± 0.66**
Naming	1.42 ± 0.79	1.42 ± 0.72	1.88 ± 0.61*

Two-tailed *t*-tests against 1.5 chance score: *$p < 0.01$; **$p < 0.001$.

and mean total scores per condition). Total scores per condition could range from 0 to 3.

The children with Williams syndrome chose the second object of the visual pair significantly more than chance ($t(11) = 6.20$, $p < 0.001$), while they chose the second object of the named pair at chance ($t(11) = -0.36$, $p = 0.72$). Paired *t*-tests further established that the children were responding significantly better in the visual than in the naming condition ($t(11) = 3.80$; $p = 0.003$). Better performance on the visual task was found for 10 of the 12 children. Finally, all children but one chose the appropriate paired object on the final visual trial.

Correlation analyses: Pearson correlation analyses were performed between the visual condition score, the naming condition score, productive vocabulary size and chronological age, as previously [23]. Note that these correlations should be considered with caution given the small number of children involved, and the fact that many children were at ceiling on the CDI vocabulary assessment. The only significant correlation involved productive vocabulary size and age, with vocabulary size increasing with age ($r = 0.65$, $p = 0.02$). The positive correlation between naming score and productive vocabulary size found in the 20-month-old controls was not replicated for the albeit considerably older children with Williams syndrome.

DISCUSSION

The present study contributes new data regarding the kinds of cue that children with Williams syndrome use to categorize objects. On one hand, the findings show that they can use visual cues to group objects together, an ability present early in typical development. Their performance is very high, with 9 of the 12 participants answering correctly to all visual trials. This result is congruent with previous findings on perceptual categorization by children with Williams syndrome [18,20]. On the other hand, the children with Williams syndrome failed to use verbal cues to form new object categories, an ability found in typical development by 20 months of age using exactly the same task [23]. Importantly, this failure cannot be due to fatigue or boredom given that the children succeeded on the final visual-based trial presented after the name-based trials. At a qualitative level, the children did not appear to hesitate or to be distressed by the name-based task. They kept answering the experimenter's requests without any apparent problem; however, their responses were at chance.

The present results hence show an advantage of the use of visual cues over verbal cues for categorization in children with Williams syndrome. These results are in contradiction with findings, based on comparisons made across many very different tasks, that older children and adults with Williams syndrome have better linguistic than visuospatial or nonlinguistic performances [18]. This underlines the importance of paying close attention to the similarity and differences in the cognitive requirements of the tasks used to assess linguistic and cognitive development, as these requirements might crucially influence the participants' performance. Our findings also highlight the fact that the advantage of linguistic over nonlinguistic performance in Williams syndrome may not be as general as previously claimed.

A second goal of the present paper was to investigate whether or not the link between lexical acquisition and the development of name-based categorization found for typically developing infants would also hold for children with Williams syndrome [23]. Our results show that, despite having developed large vocabularies, children with Williams syndrome do not pay attention to the role that names may play in the formation of new object categories. Do these results from atypical development undermine the established developmental link between lexical acquisition and name-based categorization proposed for normal development? This is not necessarily the case, because we had predicted a possible dissociation between lexical acquisition and the development of name-based categorization in this clinical group on the basis of previous results pointing to various other dissociations between lexical and cognitive development over the same development period [18,20,21]. On the contrary, we take the present results as evidence that, unlike typical development, lexical acquisition in Williams syndrome is not linked to name-based categorization. Hence, our results highlight the fact that lexical development in this syndrome follows an atypical developmental trajectory, one that is shaped from the outset by different cognitive constraints.

CONCLUSION

Recent research on Williams syndrome suggests that in adulthood people with Williams syndrome process speech differently than adults who had typical development. An increasing number of studies, ours included, further suggest

that in childhood individuals with Williams syndrome acquire language using different procedures from those found in use in typical language development. Our previous research already revealed atypical development in the way infants and toddlers with Williams syndrome isolate words from fluent speech, their failure to use pointing to refer to objects, and the unusual ways in which they learn new words [17,19]. The present results establish a dissociation between lexical acquisition and the development of name-based categorization in early childhood, bringing further support to the proposal of a dissociation between lexical acquisition and cognitive development in this population [18,20,21]. This body of research suggests that language acquisition in Williams syndrome is atypical very early on, involving numerous skills at different levels of word acquisition. Our task in the future will be to trace language development beyond toddlerhood, and to specify the kind of atypical procedures that individuals with Williams syndrome use in order to ultimately develop a language that far surpasses that witnessed in other developmental disorders.

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