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# Word learning in a special population: do individuals with Williams syndrome obey lexical constraints?*

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ABSTRACT

Williams syndrome (WS), a rare neurodevelopmental disorder, is of special interest to developmental psycholinguists because of its uneven linguistico-cognitive profile of abilities and deficits. One proficiency manifest in WS adolescents and adults is an unusually large vocabulary despite serious deficits in other domains. In this paper, rather than focus on vocabulary size, we explore the processes underlying vocabulary acquisition, i.e. how new words are learned. A WS group was compared to groups of normal MA-matched controls in the range 3–9 years in four different experiments testing for constraints on word learning. We show that in construing the meaning of new words, normal children at all ages display fast mapping and abide by the constraints tested: mutual exclusivity, whole object and taxonomic. By contrast, while the WS group showed fast mapping and the mutual exclusivity constraint, they did not abide by the whole object or taxonomic constraints. This suggests that measuring only the size of WS vocabulary can distort conclusions about the normalcy of WS language. Our study shows that despite equivalent behaviour (i.e. vocabulary test age), the processes underlying how vocabulary is acquired in WS follow a somewhat different path from that of normal children and that the atypically developing brain is not necessarily a window on normal development.

[*] This study forms part of the PhD thesis of Tassos Stevens entitled 'Language acquisition in Williams syndrome: lexical constraints and semantic organisation', under the supervision of Karmiloff-Smith. We would particularly like to thank Julia Grant for checking the text, appendices, tables and references, and for many forms of assistance during the preparation of the thesis on which this paper is based. Useful comments from two anonymous reviewers on the earlier version are gratefully acknowledged. We wish to express our sincere gratitude to the Williams Syndrome Foundation UK for putting us in touch with families whom we warmly thank for their participation in the research. For their help with setting up the testing of the normal control groups, we thank Mr Paul Smith of Holloway School for Boys, as well as Mr Christopher Hotham and the staff and pupils of Tufnell Park Primary School. Address for correspondence: Tassos Stevens or Annette Karmiloff-Smith, MRC-CDU, 4 Taviton Street, London WC1H OBT, UK.

## INTRODUCTION

Williams syndrome (WS), a rare neurodevelopmental disorder of genetic origin, has the interesting characteristic for developmental psycholinguistics of resulting in an uneven cognitivo-linguistic profile in which language is relatively preserved in the face of severe deficits in number, problem solving and spatial cognition (Williams, Barrett-Boyes & Lowe, 1961; Kataria, Goldstein & Kushnick, 1984; Arnold, Yule & Martin, 1985; Udwin, Yule & Martin, 1987; Bellugi, Marks, Bihrle & Sabo, 1988; Crisco, Dobbs & Mulhern, 1988; Bihrle, Bellugi, Delis & Marks, 1989; Bellugi, Bihrle, Neville, Jernigan & Doherty, 1992; Karmiloff-Smith, 1992*a*, *b*; Volterra, 1994; Karmiloff-Smith, Klima, Bellugi, Grant & Baron-Cohen, 1995; Volterra, Capirci, Pezzini, Sabbadini, & Vicari, 1996; Karmiloff-Smith, Grant, Berthoud, Davies, Howlin & Udwin, 1997: Mervis & Bertrand, in press; Mervis, Morris, Bertrand & Robinson, in press). Initial reports claimed that WS syntax was intact, with some indication of unusual or aberrant semantics (Bellugi et al., 1988; Reilly, Klima & Bellugi, 1990; Bromberg, Ullman, Marcus, Kelley & Levine, 1994; Rossen, Bihrle, Klima, Bellugi & Jones, in press; but see Tyler, Karmiloff-Smith, Voice, Stevens, Grant, Davies, Howlin & Udwin, in press). More recently, challenges have been reported with respect to WS morphosyntax (Karmiloff-Smith, Tyler, Voice *et al.*, in press; Karmiloff-Smith *et al.*, 1997; Volterra *et al.*, 1996), confirming the caution expressed by the original researchers in this field who warned about the risk of overestimating WS language (Udwin & Yule, 1990).

Nonetheless, there is no doubt that compared to other populations with equivalent general cognitive impairments, older individuals with Williams syndrome have impressive vocabularies. A review of the literature of WS adolescents and young adults highlights the size and variety of their productive lexicons (Bellugi *et al.*, 1988; Stevens, 1996; Rossen *et al.*, in press). Vocabulary scores are often closer to WS chronological age than to their general mental age. Indeed, there is general agreement that lexical acquisition in this syndrome, whose population has IQs mainly in the 50s to 60s, is unusually good. Compared to the rest of their profile, scores on tests such the Peabody (Dunn & Dunn, 1982) or the British Picture Vocabulary Scale (Dunn, Dunn & Whetton, 1982) are surprisingly high from an otherwise mentally impaired population. This may not be true at younger ages, however. For example, Thal, Bates & Bellugi (1989) report on the linguistic abilities of two young WS children (aged 1;4 and 5;3 years), both of whose productive vocabularies were much lower than would be expected for their chronological age (see, also, Udwin *et al.*, 1987; Volterra, 1994; Volterra *et al.*, 1996). This suggests that vocabulary proficiency is slow to develop, which leads to the following question: Does lexical acquisition in WS follow the normal developmental path but with simple delay, or does the learning pattern follow a different path? To answer this, it is necessary to go beyond the mere quantification of vocabulary size and to focus on the processes by which individuals with WS acquire their subsequently large vocabularies. Do they obey the same constraints on lexical acquisition as have been shown to obtain for normally developing children (Markman, 1990; Waxman, 1990; Hall & Waxman, 1993; Golinkoff, Mervis & Hirsh-Pasek, 1994)? This paper centres on these questions, focusing not on vocabulary size, but on HOW children with Williams syndrome go about learning new words.

An initial clue to early word learning in this population comes from work by Mervis & Bertrand (in press; see also Mervis *et al.*, in press). They compared the abilities of WS and normal children on four related phenomena: pointing, exhaustive sorting, spontaneous fast mapping, and the onset of the vocabulary spurt. Exhaustive sorting involves the separation of a set of objects from various categories into groups of objects of a similar basic-level category. The fast mapping constraint stipulates that novel words map onto objects for which the child does not already have a name (Golinkoff *et al.*, 1994; Mervis & Bertrand, 1995). The vocabulary spurt usually occurs after a period of slow learning of new words until the child's lexicon reaches about 100–150 words, at which point the rate of producing new words increases suddenly and exponentially.

Cross-sectional and longitudinal data from normally developing toddlers and from children with Down's syndrome indicate that pointing precedes naming (Mervis & Bertrand, in press). By contrast, the six WS children examined by Mervis and Bertrand did not show this pattern: in Williams syndrome naming preceded pointing by several months. In normal children and in those with Down's syndrome, spontaneous exhaustive sorting coincides with the appearance of fast mapping and with the vocabulary spurt. Again, Mervis & Bertrand showed that these capacities did not coincide in Williams syndrome. Five of the 6 WS children studied had already undergone some form of vocabulary spurt at a time when none of them yet showed signs of exhaustive sorting. Exhaustive sorting coincided with fast mapping but not until the children's vocabularies were well beyond the vocabulary spurt and had reached around 500 words.

This implies that although fast mapping may be one method of rapidly increasing vocabulary levels (used by normal and Down's syndrome children), it is not the only one. Williams syndrome children must call on alternative strategies. Mervis & Bertrand speculate that they may rely on their good phonological short-term memory for words (see, also, Vicari *et al.*, 1996*a*; Vicari, Carlesimo, Brizzolara & Pezzini, 1996*b*; Grant, Karmiloff-Smith, Gathercole, Paterson, Howlin, Davies & Udwin, 1997), paying special attention to verbal input at the expense of other multiple stimuli of interest to normally developing children.

The issue of early lexical constraints in normal development has received

TABLE 1. *Participation of WS participants in Experiments 1–4*

| Subjects | Experiment 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| AA | + | + | + | + |
| CC | + | − | + | + |
| DD | − | − | − | + |
| EE | + | + | + | + |
| FF | + | + | + | + |
| GG | − | − | + | − |
| HH | + | + | + | + |
| II | + | + | + | + |
| JJ | − | − | + | − |
| KK | + | + | + | − |
| LL | − | − | + | − |
| MM | + | − | − | + |
| NN | − | + | + | + |
| OO | + | + | + | + |
| PP | + | + | + | + |
| QQ | + | + | + | + |

a lot of attention in recent years (e.g. Markman & Wachtel, 1988; Markman, 1990, 1994; Waxman, 1990; Hall & Waxman, 1993; Golinkoff et al., 1994). Markman and her colleagues have tested a number of constraints in three-year-olds. Two constraints are taken to be essential for the fast establishment of the referent for a novel word: the mutual exclusivity constraint and the whole object constraint. The mutual exclusivity constraint stipulates that an object cannot have more than one name. The whole object constraint stipulates that a novel word heard in the presence of a novel object refers to the whole object rather than to its component parts of features such as colour, shape or texture. A study by Markman & Wachtel (1988) demonstrated that both the mutual exclusivity and whole object constraints are used by normal children as young as 3 years to identify the referent of a new word. A fourth constraint (Markman, 1990) – the taxonomic constraint – is also operative in the vocabulary acquisition in normal children. It stipulates that in the presence of a novel word (X) for an object, children will, when requested for another X, choose an X from the same taxonomic category (e.g. dog–lion), and not one simply with the same colour, texture or shape but from another taxonomic category, nor one related thematically (e.g. dog–bone).

In attempting to explore how Williams syndrome children acquire their vocabularies, it is essential to look at a range of different constraints. In this paper we present four experiments aimed at examining whether the same lexical constraints on word learning found in normally developing children are also operative for WS individuals. We focus on the constraints discussed



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above which have been extensively tested with normal three-year-olds: fast mapping, mutual exclusivity, whole object and taxonomic constraints. To cover the upper range of the mental ages of our WS group, we also included groups of nine-year-old controls. This was to ensure that at all ages children abide by such constraints when learning new words, and not solely during the early stages of language acquisition.

Table 1 gives details of which of the WS individuals participated in each of the four experiments. Testing for each of the experiments was spread over a period of 18 months for each subject. Where the same stimuli were used in more than one study with the same subject, the test sessions were at least 9 months apart.

## EXPERIMENT 1 – FAST MAPPING

The fast mapping hypothesis stipulates that novel words map onto objects for which the child does not already have a name. We first replicated the findings of Mervis & Bertrand for fast mapping with two groups of normal controls, using a similar methodology.

### METHOD

#### *Population*

Two control groups of normal schoolchildren were tested, with 12 children in each group. The younger three-year-old group had a mean age of 3;6, (range = 3;0–3;10). The older nine-year-old group had a mean age of 9;7 (range = 9;1–9;10). There were equal numbers of males and females in each group.

Eleven WS participants were tested. Their mean age was 20;0 years (range = 8;7–31;2). There were 4 males and 7 females in the group. The WS group was from similar lower middle to middle class socio-economic backgrounds as the normal controls. The WISC/WAIS IQ (test selected according to age) of the WS group was in the range 48–76 (mean: 58·9). Scores on the BPVS (British Picture Vocabulary Scale, Dunn & Dunn, 1982; Dunn, Dunn & Whetton, 1982) gave a vocabulary mental age in the range 4;5–16;4 (mean: 9;4). Their mental age on the TROG (Test of Reception of Grammar, Bishop, 1983) was between 4;0 and 11;0 (mean: 7;1). Finally, their non-verbal mental age on Raven's Progressive Matrices (Raven, 1986) was in the range 3;6–8;3 (mean: 5;10).

#### *Design and procedure*

Prior to the experiment proper, the familiarity of the objects was assessed. Two pools of objects were used. One pool contained objects thought to be familiar to children of all ages; the other contained objects thought to be unfamiliar to children of all ages. For the familiar group, ten three-year-olds were asked to name the objects. A pool of experimental objects was chosen of those named most reliably. For the unfamiliar group, 10 adults were asked to name the objects, and a pool of experimental objects was chosen of those that were not named reliably. A further criterion for the selection of objects was to ensure that there was an equal number of attractive, shiny objects in each pool. The 16 items used for familiar and unfamiliar pools in the experiment are listed in Appendix 1.

Before each experimental session, the objects were divided into 4 pools of 4 objects per pool, each with 2 familiar objects and 2 unfamiliar objects. Eight novel names were assigned to the unfamiliar objects, from a pool of 16 novel words listed in Appendix 1. Eight of this pool were monosyllabic, 8 were bisyllabic. Four of each were used for each participant. The novel words were counterbalanced across individuals.

Participants in the experiment proper were presented with an array of objects, one unfamiliar and the rest familiar. There were four trials, each with two sub-trials. In the first sub-trial of each trial, there were two familiar objects and one unfamiliar object. The same objects were used in the second sub-trial of each trial, with the addition of a further unfamiliar object.

For each trial, the procedure was as follows. The experimenter and participant sat at a table. The experimenter laid out two of the familiar objects and one of the unfamiliar objects in a line on the table, the order of familiar and unfamiliar in the array being counterbalanced across trials. The experimenter then placed both his hands beneath the table, and taking care to look only at the participant and not at the objects, asked 'Do you see these. Could you please pass me the X', where X was a novel word. According to the fast mapping hypothesis, a novel word should be mapped onto the unfamiliar object. Once the participant had made a choice, the experimenter picked up the object chosen and then proceeded to give a short description of the use of that object. The experimenter then picked up all the objects, and drawing them under the table, added the second unfamiliar object, and then laid all four objects on the table in a new array. A new novel name was produced and the procedure repeated. If the child is capable of using fast mapping, then the second novel word should be mapped onto the additional unfamiliar object, because the first unfamiliar object was labelled in the first sub-trial. A total of 8 data points per participant was collected for the groups, i.e. 4 trials, each with 2 sub-trials.

## RESULTS

The number of unfamiliar items selected by each participant was compared against the probability of selecting those items by chance. For each first subtrial, the chance probability of selecting the unfamiliar object is 1 in 3.

TABLE 2. *Chance of selecting unfamiliar object from array of 3 in first subtrial*

| Number of trials with 1st subtrial correct | Odds of this occurring by chance | Chance probability $P_1$ |
|---|---|---|
| 1 | 32/81 | 0·40 |
| 2 | 48/81 | 0·59 |
| 3 | 8/81 | 0·10 |
| 4 | 1/81 | 0·01 |

TABLE 3. *Chance of selecting unfamiliar object from array of four in second subtrial*

| Number of trials with 2nd subtrial correct | Odds of this occurring by chance | Chance probability $P_2$ |
|---|---|---|
| 1 | 108/256 | 0·42 |
| 2 | 108/256 | 0·42 |
| 3 | 12/256 | 0·05 |
| 4 | 1/256 | 0·003 |

The chance probability of consistently selecting either of the familiar objects is 2 in 3. The chance probability of selecting the unfamiliar object in the first subtrial over the four trials is given in Table 2.

For each second subtrial, the chance probability of selecting the unfamiliar object is 1 in 4. The chance probability of selecting either of the familiar objects is 3 in 4. Table 3 gives the chance probability of consistently selecting the unfamiliar object in the second subtrial over four trials.

For any individual, the probability that their results demonstrate fast mapping rather than occurring as a result of chance can be calculated by multiplying the chance probabilities of their scores in the first subtrial, $p_1$, and in the second subtrial $p_2$. If this resulting score ($p_1 \times p_2$) is less than 0·05, then we can conclude that individual is demonstrating the fast-mapping ability.

The number of trials in which the hypothesized object was selected in the first and second sub-trials demonstrated that both the three-year-old and the nine-year-old normal control groups have the fast-mapping ability ($p < 0{\cdot}05$). In both age groups, this held for every individual tested and was not merely a group effect. There was no difference in the fast-mapping ability between the younger and older control groups.

The results for the WS group were almost identical to those of the normal controls, showing that the WS group also have fast-mapping ability ($p < 0{\cdot}05$). Again, this was not only a group effect but obtained for all 11 of the WS



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individuals tested. There was no difference in fast-mapping ability between the WS experimental group and the two control groups.

DISCUSSION

Fast-mapping ability is demonstrated by every participant from the two normal control groups and also from each of those in the WS group. Both the WS group and the normal controls are capable of fast mapping. This replicates on a much broader age range the findings of Mervis & Bertrand (in press) whose study was limited to a young WS group only.

## EXPERIMENT 2 – MUTUAL EXCLUSIVITY CONSTRAINT

The mutual exclusivity constraint stipulates that an object cannot have more than one name. This experiment was based on the second part of Study 2 of Markman & Wachtel (1988).

METHOD

*Population*

Two groups of controls were tested. We first screened 22 three-year-olds to see which of them could reliably name all the familiar objects and parts of objects. Ten failed to do so, so they were not included in the experiment. The remaining 12 children were aged 3;0–3;11 (mean: 3;5). The older group was composed of 12 nine-year-olds, in the range 9;0–9;11 (mean: 9;6). In both groups of controls, there was an equal number of males and females. The socio-economic status of all the controls was the same as the WS group, i.e. middle to lower middle class.

Twelve WS individuals were tested. Two could not reliably name all the familiar objects and parts, so they were not included. The 10 remaining WS participants formed the experimental group. Five were male and 5 female. Their ages were in the range 8;0–30;5 (mean: 19;6). The WISC/WAIS IQ of the WS participants was in the range 48–76 (mean: 59·6). Scores on the BPVS gave a vocabulary mental age in the range 6;8–16;4 (mean: 9;9). Their mental age on the TROG was between 5;3 and 11;0 (mean: 7;6). Finally, their non-verbal mental age on the Raven's was in the range 3;6–8;3 (mean: 6;3).

*Design and procedure*

As with Experiment 1, preliminary studies were carried out to test and rate the familiarity of the stimuli on groups of nine-year-olds and adults. The familiar/unfamiliar objects were then assessed for the visual salience of the parts. Ten adults were presented with the drawings and asked to rate from 1 to 10 (10 being very prominent) the visual salience of the parts of each object. Those objects were chosen for final sets in each condition of familiarity for which there was no significant difference in the judgements of visual salience of parts.

On initial testing with the group of nine-year-olds who took part in the experiment proper, one of the items already successfully used with the three-year-old group (fish/dorsal [fin]) was found to produce predominantly object responses (fish) when the part name (dorsal) was used. It was reasoned that this was because the nine-year-olds already had a reliable name for the part (fin) and were therefore overriding the mutual exclusivity constraint and using the whole object constraint for deciding that dorsal must be a second word for the whole object. We therefore decided to replace this item by another (spanner/ratchet) for testing with the nine-year-old and WS participants. the full list of names used are listed in Appendix 3. Examples of drawings used are given in Appendix 4.

The set of drawings of the stimuli were presented in a laminated book. Two drawings of familiar objects were used for practice items. There were six drawings of familiar objects with familiar parts and six drawings of familiar objects with unfamiliar parts. These were taken from a larger pool of drawings, from which items were used for all participants. The number of times any particular drawing was used was standardized between age groups of the controls.

Participants were given a stimulus sentence 'This is a X', in conjunction with a drawing of an object with a salient part. The word (X) referred to either the whole object or the part. A total of 12 items was presented to each participant. Six words referred to whole objects, all of which were familiar. Six words referred to parts of objects, 3 of which were familiar and 3 unfamiliar. Participants were asked to indicate whether the whole object was the X or whether the part was the X. The design was within-groups for comparison of the effect of familiarity, between-groups for comparison of the effect of age.

Each participant was seen individually, sitting opposite the experimenter at a table in a quiet room. He or she was told: 'Today we're going to play a game, to do with the whole of an object or with just a part of it.' The participant was given real-object examples of objects with parts such as the table and leg, the (experimenter's) face and nose, the (participant's) hand and finger, and was encouraged to point out any other examples. The participant was then told: 'I'm going to show you some things now, and I want you to tell me if it's the whole of an object (experimenter drew a large circle with his finger on the table) or just a part of it (experimenter drew a small circle with his finger on the table).'

Then the book of drawings was produced, and the child was given two practice items. For each item, before it was shown, the experimenter said: 'This is a X.' The drawing was then shown to the child and the experimenter said 'Which is the X? Is this the X (experimenter drew a large circle with his finger around the whole object), the whole thing? Or is this the X (experimenter drew a small circle with his finger around the part), this part?' The second practice item was either the part or whole object, depending on which was used first. Participants were encouraged to make a response using their finger to mimic the experimenter. If the participant made a mistake during the practice items, the experimenter would explain why that response was wrong until he or she made the correct response and appeared to understand why.

Then followed trials with 6 familiar objects with familiar parts, alternating with 6 familiar objects with unfamiliar parts. The procedure was exactly the same as the practice items, except that no extra help was given if the participant made a mistake. During experimental trials, the participant's first firm response was taken as the response. Whether the object or the part was indicated first by the experimenter was counter-balanced across trials.

## RESULTS

The numbers of whole object responses by each participant made in the familiar whole/familiar part and familiar whole/unfamiliar part stimulus categories were summed. The number of object/part responses made by the WS group and normal controls in each age group for each category of familiarity of item is shown in Fig. 1.

Fig. 1 shows that for the WS group the mean number of object responses made in the familiar object/familiar part category was the same as that made by the nine-year-old group and slightly less than that by the three-year-old group. The mean number of object responses in the familiar object/unfamiliar part category was also the same as the nine-year-old group and slightly less than that by the three-year-old group.

A two-way mixed ANOVA was carried out to investigate the effects of familiarity of parts and age of participants on the number of object responses made by control groups. Neither the effect of part familiarity on the number of object responses made ($F_{1,22}$ ratio $= 0{\cdot}881$ $p > 0{\cdot}05$), nor the effect of age of participant ($F_{1,22}$ ratio $= 0{\cdot}786$, $p > 0{\cdot}05$) was significant. The interaction between the two variables was also non-significant ($F_{1,22}$ ratio $= 0{\cdot}35$, $p > 0{\cdot}05$). Follow-up one-tail paired t-tests were carried out to test for the significance of the effect of familiarity of part stimuli on the number of object responses made in each age group. There is no significant difference between the number of object responses made in the familiar objects/familiar parts condition and the familiar object/unfamiliar parts condition (d.f. $= 11$, $t = -0{\cdot}9$, $p > 0{\cdot}05$) for the three-year-old normal control group, nor is there for the older nine-year-old normal control group (d.f. $= 11$, $t = -0{\cdot}5$, $p > 0{\cdot}05$).



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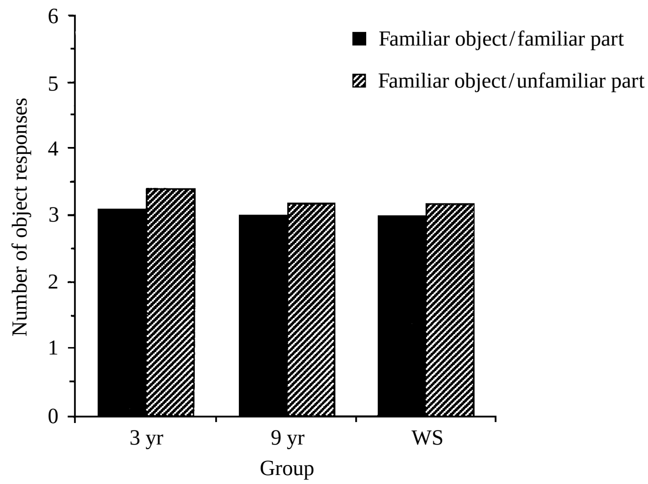


Fig. 1. Mean number of object responses for familiar objects/familiar parts and familiar objects/unfamiliar parts across groups.

Of the 10 WS individuals, 9 made 3 object responses in the familiar object/unfamiliar part category, and 1 made 5 object responses in that category. For the WS group, a paired t-test on the number of object responses made in each category was carried out. No significant difference was found (d.f. = 9, $t = -1$, $p > 005$).

DISCUSSION

The results show that, like the normal control groups of three- and nine-year-olds, the mutual exclusivity constraint is also operative in individuals with Williams syndrome. There was no significant difference in the number of object responses made between conditions, across all groups. There was also no significant effect of the age of participants on the number of object responses made. These results replicate on a much wider age range those of Markman & Wachtel (1988), who focused on children of mean age 3;4 only. Again, there was no effect of age of participant on the responses made. In sum, like the normal controls, the WS group mapped the novel word onto the part for stimuli where the object was familiar but the salient part unfamiliar, thereby demonstrating that they abide by the mutual exclusivity constraint.

## EXPERIMENT 3 – WHOLE OBJECT CONSTRAINT

The whole object constraint stipulates that a novel word heard in the presence of a novel object refers to the whole object, rather than to its component parts or features such as colour, shape or texture. This experiment was based on the first part of study 2 in Markman & Wachtel (1988).



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## METHOD

### *Population*

Forty normal controls participated. Like the other constraints, the whole object constraint had hitherto only been tested on very young children. Instead of simply taking a second control group of nine-year-olds, this time we also wished to ensure that there was no U-shaped developmental path between 3 and 9 years. We therefore tested four age groups of normal controls, with 10 participants per group: three-year-olds (range: 3;0–3;10; mean 3;4), five-year-olds (range: 5;1–5;9; mean 5;3), seven-year-olds (range: 7;0–7;11; mean 7;6), and nine-year-olds (range: 9;1–9;9; mean 9;4). There was an equal number of males and females in each of the groups.

Fourteen WS participants formed the experimental group. Six were male and 8 female. Ages were in the range 7;5–31;5 (mean: 20;1). The WISC/WAIS IQ of the WS group was in the range 48–76 (mean: 62·3). Scores on the BPVS gave a vocabulary mental age in the range 6;8–16;4 (mean: 9;11). Their mental age on the TROG was between 4;6 and 11;0 (mean: 7;6). Finally, their non-verbal mental age on the Raven's was in the range 3;6–9;0 (mean: 6;4). The socio-economic status of the WS group was again similar to that of the control groups, i.e. middle to lower middle class.

### *Design and procedure*

The design procedure and pre-testing of experimental items were similar to those for Experiment 2, except that this time we used both familiar and unfamiliar objects and parts. Six familiar object trials alternated with 6 unfamiliar object trials, with the usual counterbalancing across trials of whether the object or the part was indicated first by the experimenter. The final selection of stimulus items used in this experiment is given in Appendix 5 and examples of the drawings in Appendix 6. For one of the unfamiliar items, *lung*, 90% of the responses of the normal controls were made for the part, *bronchiole*. That item was then replaced with another, *amoeba*, with salient part *pseudopod*, before the WS group was tested.

## RESULTS

The number of whole object responses made by each participant in the familiar and unfamiliar object categories was summed. The number of object responses made by the WS group and normal controls in each of the age groups for each category of familiarity of item is shown in Fig. 2.

For the WS group, the mean number of object responses made in the familiar category was the same as that made by all age groups of normal

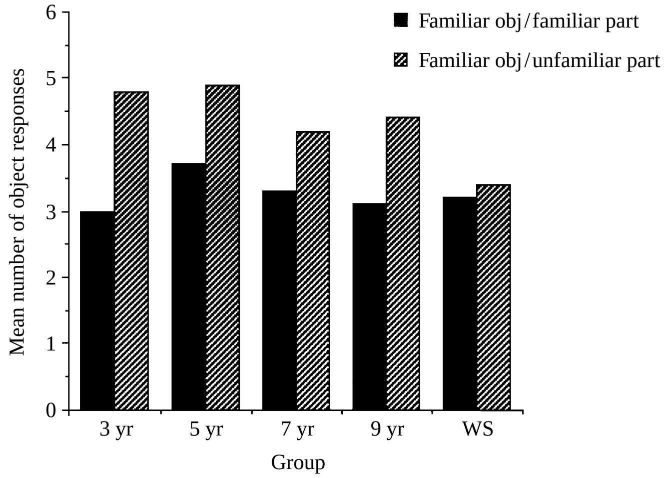


Fig. 2. Mean number of object responses for familiar objects/familiar parts and unfamiliar objects/unfamiliar parts across groups.

controls. However, the mean number of object responses made in the unfamiliar category was considerably lower than the mean across all age groups of controls.

A two-way mixed design ANOVA was carried out to investigate the effects of familiarity of objects and age of normal controls on the number of object responses made. The effect of familiarity on the number of object responses made was significant ($F_1$, 12 ratio $= 5{\cdot}73$, $p < 0{\cdot}025$). Neither the effect of age of participant ($F_3$, 12 ratio $= 0{\cdot}35$, $p > 0{\cdot}05$) nor the interaction between the two variables ($F_3$, 12 ratio $= 0{\cdot}35$, $p > 0{\cdot}05$) was significant.

For the WS group, no significant correlation was found between the chronological age of participants and the number of unfamiliar whole object responses made (simple linear regression, $R = 0{\cdot}1$, d.f. $= 11$, $F = 0{\cdot}1$, $p > 0{\cdot}05$). Neither was there a significant correlation between the number of responses made and BPVS (simple linear regression, $R = 0{\cdot}2$, d.f. $= 11$, $F = 0{\cdot}3$, $p > 0{\cdot}05$) or TROG (simple linear regression, $R = 0{\cdot}3$, d.f. $= 11$, $F = 0{\cdot}6$, $p > 0{\cdot}05$).

A paired $t$-test on the number of whole object responses made in each category was carried out for the WS group. No significant difference was found (two-tailed paired $t$-test, d.f. $= 13$, $t = -1{\cdot}1$, $p > 0{\cdot}05$).

For the control groups, there were significantly more whole object responses made in the unfamiliar condition as compared to the familiar condition. There was no interaction effect of the age of the participants on this increase in number of whole object responses in the unfamiliar condition. Follow-up paired $t$-tests were carried out to test for the significance of the



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effect of familiarity of stimuli on the number of object responses made in each age group. There was a significant increase in the number of object responses made in the unfamiliar objects category compared to the familiar category for all age groups: three-year-old group (d.f $= 9$, $t = -3.042$, $p < 0.01$), five-year-old-group (d.f. $= 9$, $t = -4.74$, $p < 0.001$), seven-year-old group (d.f. $= 9$, $t = -2.1$, $p < 0.05$) and nine-year-old group (d.f. $= 9$, $t = -3.28$, $p < 0.005$).

### DISCUSSION

Unlike the normal controls across all ages from 3 to 9 years, a whole object constraint does not seem to be present in people with Williams Syndrome. For the normal controls, significantly more whole object responses were made in the unfamiliar condition than in the familiar condition across all age groups. There was no significant effect of the age of participants on the number of whole object responses made. These results replicate those of Markman & Wachtel (1988), who focused on children of mean age 3;4 years, but extend them across a much wider age range. However, the difference in the number of object responses made in each condition is not as strong in the present study as in the Markman & Wachtel study. This is probably due to the anomalous effect of one of the unfamiliar stimuli used, the lung. Despite no difference in the adult rating for the visual salience of its part (bronchiole), almost all responses made by all controls for this item were part responses, suggesting that for children this part is in fact extremely salient. When the results from this item are removed from the control data, then the level of the difference between the number of whole object responses made in each condition by our normal controls is comparable to that found by Markman & Wachtel (1988).

For the WS group, by contrast, the picture is very different. There was no significant difference between the number of whole object responses made for familiar and unfamiliar items. For the whole object constraint to be operative, the WS participants should have made significantly more whole object responses in the unfamiliar condition than in the familiar condition. They did not. This indicates that, unlike normal development from 3;0 onwards, the whole object default is not operative for WS individuals. Whatever the processes by which they go about their word learning, they are not constrained by the whole object constraint.

## EXPERIMENT 4 – TAXONOMIC CONSTRAINT

The taxonomic constraint stipulates that in the presence of a novel word (X) for an object, children will, when requested for another X, choose an X from the same taxonomic category (e.g. dog–lion), and not one simply with the same colour, texture or shape but from another taxonomic category, nor one related thematically (e.g. dog–bone). A child is deemed to display a 'taxonomic bias' if he or she selects more taxonomically related objects in the presence of a novel word than with a simple deictic 'that' and no word provided. The procedure used in experiment 4 was based on a study carried out with normal three-year-olds (Golinkoff *et al.*, 1994).

### METHOD

*Population*

Two age groups of normal school children took part: 32 three-year-olds in the range 3;1–4;4 (mean: 3;10), and 12 nine-year-olds in the range 8;11–9;10 (mean: 9;5). There were an equal number of males and females in each of the groups.

Twelve WS participants were tested, in the range 8;6–30;11 (mean: 19;9). Five were male and 7 female. The WISC/WAIS IQ of the WS group was in the range 48–76 (mean: 56·4). Scores on the BPVS gave a vocabulary mental age in the range 4;5–16;4 (mean: 9;1). Their mental age on the TROG was between 5;3 and 11;0 (mean: 6;9). Finally, their non-verbal mental age on the Raven's was in the range 3;6–8;3 (mean: 5;4).

*Design and procedure*

In order to avoid known categories (Markman, 1990), nonce stimuli were used and the participant taught the relevant taxonomic and thematic relations for each stimulus set before the testing of each item.

Eight drawings, kept in a laminated book, were each paired with a set of three picture cards. One of the picture cards was the target. Of the other two cards, one was the taxonomic choice and the other the thematic choice. Examples of the drawings and the picture cards are shown in Appendix 7. The list of novel words used is given in Appendix 8.

Each participant was seen individually, sitting opposite the experimenter at a table in a quiet room. He or she was told: 'Today we're going to play a game, looking at some pictures.' The experimenter took the set of picture cards for the first drawing out of the laminated pocket and placed them face down on the table. The experimenter then showed the drawing to the participant, saying 'Look what's going on here', followed by a brief relevant description that identified the taxonomic and thematic relations for the target. The experimenter pointed at relevant parts of the picture during the description. Examples of thee descriptions are given with the drawings in Appendix 7. The experimenter then closed the book of drawings and picked up the target picture card.



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There were two conditions: novel-word/no-word. Apart from providing a word or not, the instructions in the two conditions were identical. In the no-word condition, the experimenter said 'Do you see this one here. Can you show me another one, that goes with this one here', then turned over the two response cards, and repeated 'that goes with this one here'. In the novel-word condition, the experimenter said 'Do you see this X here. Can you show me another one, that goes with this X here', then turned over the two response cards, then repeated 'that goes with this X here'. X was the novel word used for that item. In both conditions, the experimenter then waited until the participant picked either a taxonomic or a thematic response, marked down that response, then said 'OK. Let's have a look at this' and repeated the procedure for the next item.

In addition to the novel-word/no-word conditions, the stimuli were composed of two colour conditions in which the target and taxonomic/thematic choice pictures were either of the same colour or different. One, both or neither of the choice pictures was coloured the same as the target picture, as in the following example with real words:

| | *Target object* | *Taxonomic choice* | *Thematic choice* |
|---|---|---|---|
| *1* | green 'ball' | red 'ball' | red 'footballer' |
| *2* | green 'ball' | red 'ball' | green 'footballer' |
| *3* | green 'ball' | green 'ball' | red 'footballer' |
| *4* | green 'ball' | green 'ball' | green 'footballer' |

Colour condition 1 has taxonomic and thematic coloured the same as each other, but both different from the target. Colour condition 2 has thematic the same as the target, but the taxonomic different. Colour condition 3 has taxonomic the same as the target, but thematic different. Colour condition 4 has all, taxonomic, thematic and target, coloured the same. All colour conditions were repeated for the novel-word and no-word conditions.

Order of presentation of stimuli was counterbalanced across participants and conditions. The order of conditions was counterbalanced across participants. The choice of novel words used in the novel condition was counterbalanced across participants. The design was within-groups for comparison of the effect of condition, between-groups for comparison of the effect of age. Participants were tested for all items in one of the conditions in one session, and repeated with all items in the other condition at least one week later. Given the repetition of colours, one might be concerned about perseveration effects in this respect. However, since performance in the two conditions in fact differed (see below), this was not a problem.

RESULTS

The number of taxonomic responses in each condition, non-word and novel-word, was summed across items for all participants in each group. The mean number of taxonomic responses in each condition is shown in Fig. 3.

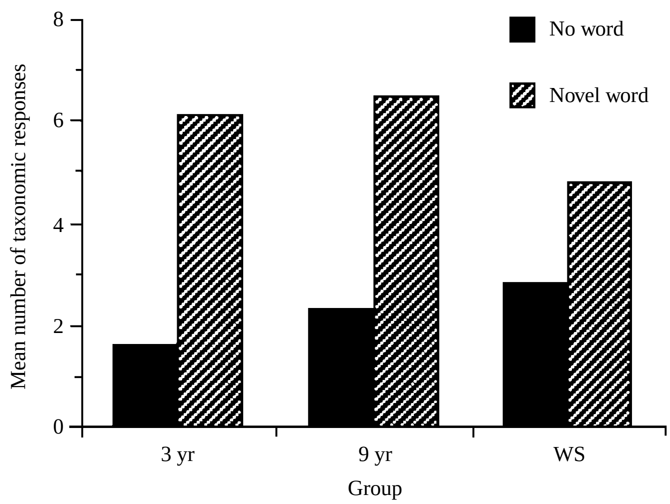


Fig. 3. Mean number of taxonomic responses in no word and novel word conditions across all groups.

For both groups of normal controls, the number of taxonomic responses in the novel word condition was significantly greater than in the no-word condition (three-year-olds: Wilcoxon Signed Rank, $N = 30$, $W = -4{\cdot}7$, $p < 0{\cdot}001$; nine-year-olds: $N = 9$, $W = -1{\cdot}3$, $p < 0{\cdot}001$). For the WS group, the difference between the number of taxonomic responses in the no-word condition and in the novel-word condition was not significant (Wilcoxon, $N = 11$, $W = -1{\cdot}6$, $p > 0{\cdot}05$). While the number of taxonomic responses made by the WS group in the no-word condition was close to the mean for the nine-year-old controls, the mean for the novel-word condition was greatly reduced relative to the nine-year-olds. The WS lack of a significant difference between conditions is therefore not caused by a greater number of taxonomic responses made in both conditions, but by the lack in the WS group of the taxonomic bias. In other words, unlike the normal controls, the WS group did not select more taxonomically related objects in the presence of a novel word than when no word was provided.

We next made an item analysis of the data. For each item, the taxonomic bias was calculated for each participant. This was done by allotting O for a



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thematic response and 1 for a taxonomic response, in both the no-word and novel-word conditions, and then subtracting the no-word response from the novel-word response. If participants adhere to the taxonomic constraint, we would expect a bias of 1 (1 in novel word condition – 0 in no-word condition for each item for each participant). The mean taxonomic bias for all participants for each item is shown in Table 4. There was no significant

TABLE 4. *Mean taxonomic bias per item* (*three- and nine-year-old normals summed*)

| Item | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Control | 0·5 | 0·4 | 0·6 | 0·6 | 0·7 | 0·7 | 0·7 | 0·5 |
| WS | 0·2 | 0·2 | 0·2 | 0·2 | 0·2 | 0·3 | 0·2 | 0·3 |

difference in the mean taxonomic biases for items either for the normal controls or for the WS group (d.f. = 7, Friedman's $\chi^2 = 6{\cdot}9$ (corrected for ties), $p > 0{\cdot}05$).

Our next analysis concerned colour similarity (perceptual similarity) between target, taxonomic response and thematic response. Item pairs 1 and 5, 2 and 6, 3 and 7, and 4 and 8, share the same relationship between colour of target, taxonomic response and thematic response, levels 1, 2, 3 and 4 respectively. The mean taxonomic bias for each level of the colour condition was calculated by summing those item pairs and dividing by 2. They are shown in Table 5. There was no significant difference between the mean

TABLE 5. *Mean taxonomic bias per colour level* (*three- and nine-year-old controls summed*)

| Colour level | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Controls | 0·6 | 0·6 | 0·7 | 0·6 |
| WS | 0·2 | 0·3 | 0·3 | 0·2 |

taxonomic biases for the four colour levels for the normal controls (d.f. = 3, $\chi^2 = 0{\cdot}7$ (corrected for ties), $p > 0{\cdot}05$), nor for the WS group (d.f. = 3, $\chi^2 = 0{\cdot}6$ (corrected for ties), $p > 0{\cdot}05$).

Finally, we assessed individual trends for the taxonomic bias, by calculating the taxonomic bias for each participant summed across all items. The vast majority of young normal control children showed a taxonomic bias between 4 and 8; only 2 out of the total 32 three-year-olds failed to show a taxonomic bias at all. All the older normal controls displayed a taxonomic bias.



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For the WS group, by contrast, there was no significant increase in the number of taxonomic responses made in the novel-word condition compared to the no-word condition, i.e. no taxonomic bias. There was also no significant difference between the mean taxonomic responses for items. Likewise, there was no significant effect on the taxonomic bias per item across the WS participants neither by the colour level of the item stimulus triads, nor of the level of categorization of taxonomic relation between target and taxonomic choice. Less than half of the WS group showed a taxonomic bias.

Our data were also analysed with respect to taxonomic level. The taxonomic biases for each participant for items in the basic level taxonomic set (items 1, 2, and 5) and those in the superordinate level taxonomic set (items 6, 7, and 8) were compared for both age groups of controls. There was no significant difference between the taxonomic biases for the two taxonomic levels for either age group (one-tailed $t$-test, three-year-old group: d.f. $= 95$, $t = -1.1$, $p > 0.05$; nine-year-old-group: d.f. $= 35$, $t = -1$, $p > 0.05$). For the WS group, there was also no significant difference between the taxonomic biases for the two levels of categorization (one-tailed $t$-test, d.f. $= 35$, $t = -1$, $p > 0.05$). Less than half of the WS group showed a taxonomic bias.

Differences between groups revealed the following. The median 12 results of taxonomic biases for the younger group of normal controls were taken, and entered in a one-way ANOVA with the 12 results of the older group of normal controls and the 12 results of the WS group. There was a significant difference between the taxonomic biases for the three groups ($F(2, 22) = 6.5$, $p < 0.01$). Follow-up Scheffé F-tests showed that there was no significant difference between the taxonomic biases for the two normal control groups, but that there were significant differences between the younger group and the WS group (Scheffé $F = 5.4$, $p < 0.05$) and between the older group and the WS group (Scheffé $F = 4.3$, $p < 0.05$).

## DISCUSSION

Our results show a significant taxonomic shift as of three years of age, with more taxonomic responses made in the novel-word condition than in the no-word condition. There was no difference in the taxonomic bias for all participants between individual items, between pairs of items in each level of colour similarity, nor between levels of categorization. Although the WS participants also showed no differences between individual items, pairs of items in each level of colour similarity, or between levels of categorization, unlike the normal controls, as a group they did not display the taxonomic bias. However, there was much more variation in the taxonomic biases within the WS group than there was within either of the normal control groups. The WS data show two clusters of scores, with the majority showing no taxonomic bias, and a smaller group showing a high positive taxonomic bias.

There is, however, no correlation between the taxonomic bias shown by each participant and any of the following: test age on the BPVS ($N = 12$, R $= 0.1$, $F_{1,10} = 0.1$, $p > 0.05$), BPVS test age divided by chronological age ($N = 12$, R $= 0.01$, $F_{1,10} = 0.001$, $p > 0.05$), and BPVS test age minus chronological age ($N = 12$, R $= 0.2$, $F_{1,10} = 0.6$, $p > 0.05$). None the less, the mean BPVS test age of the four participants who scored a taxonomic bias less than zero was relatively high (7;6); and that of the four participants who scored a taxonomic bias greater than 4 was 9;0, but this difference was not significant (unpaired *t*-test, d.f. = 6, $t = -0.9$, $p > 0.05$). In other words, although we might expect the few WS participants who did show a taxonomic bias to be more likely to have significantly better vocabulary scores, this was not the case.

In sum, individuals with Williams syndrome can acquire relatively good levels of vocabulary despite not abiding by the taxonomic constraint.

## GENERAL DISCUSSION

The four experiments in this study have shown that whereas all normal children between 3 and 9 years of age display fast mapping, and abide by the mutual exclusivity, whole object and taxonomic constraints, the WS group only reliably display fast mapping and mutual exclusivity. The WS group did not abide by the whole object or taxonomic constraints when learning new words. One might object that the WS group failed to show these two constraints due to difficulties with the experimental procedures. Such an explanation can be ruled out, however, since WS participants did abide by the mutual exclusivity constraint which was tested by virtually the same experimental procedure as the whole object constraint.

It is clear that fast mapping cannot alone explain the levels of vocabulary typical of people with Williams syndrome, since fast mapping has also been established with a Down's syndrome (DS) group (Chapman, Kay-Raining-Bird & Schwartz, 1990) whose vocabulary levels in adulthood are considerably lower than those of WS groups (Bellugi *et al.*, 1988; Mervis & Bertrand, in press; Mervis *et al.*, in press). Although our few WS participants who showed a taxonomic bias did not have significantly better vocabulary scores than those who did not, this may be because our participants were older. Indeed, Mervis & Bertrand (1995; see also Chapman *et al.*, 1990) have shown that YOUNGER DS children who display fast mapping do have larger vocabularies than those who do not. It therefore seems probable that fast mapping is an early prerequisite to help kick-start rapid initial word learning, but it is insufficient to explain the later differences in expressive and receptive vocabularies between WS and DS.

Why do WS individuals not abide by the same set of constraints that normal children continue to do between 3;0 and 9;0? Although Markman

(1990, 1994) claims that lexical constraints are part of a system available simultaneously to the normal three-year-old, according to Golinkoff and colleagues (Golinkoff *et al.*, 1994), lexical constraints become operative at different rates, with the taxonomic bias displayed last in normal development. This could explain the failure of WS people to use this constraint consistently, in that their language acquisition takes off much later than in normal development and seems to plateau earlier than in the normal case in terms of the ways in which further learning takes place. Indeed, it has been shown that even in adulthood the relationship between phonological patterns and vocabulary displayed by WS people is at the level of normal four-year-olds and not five-year-olds (Grant, Karmiloff-Smith, Berthoud & Christophe, 1996; Grant *et al.*, 1997).

One possible explanation for our results is that the organization of lexical storage in WS is aberrant. Whilst this interpretation is rendered less likely by the findings of a primed monitoring study (Tyler *et al.*, in press) in which WS performance was similar to normal controls, the organization of the WS lexicon merits further exploration. It is also possible that the focus that the WS participants displayed with respect to parts is due to their componential processing in tasks that actually require attention to the whole (Bellugi *et al.*, 1988). However, Stevens (1996) failed to replicate these previous findings, by separating problems in the planning and execution of a drawing, versus the perception of the stimulus to be drawn. When asked to describe VERBALLY figures composed of small parts forming a patterned whole (e.g. an H made of little X's), the majority of the WS participants mentioned both the parts and the whole. The part–whole confusion previously reported in the WS literature may therefore lie more in drawing production than in deviant perception. One further possibility is that the problem that WS participants have with certain lexical constraints is more to do with their general retardation than anything syndrome-specific. The disparity between mental age and chronological ages means that atypical groups have far more experience of everyday objects and a large store of world knowledge despite their cognitive limitations. This may interact with learning procedures. This question still needs to be explored in depth, and it is clear that cross-syndrome explorations are crucial in order to separate general retardation from domain-specific deficits.

In sum, our study has shown that the relatively high vocabulary scores displayed by people with WS do not necessarily reflect a normal developmental pathway. Reaching an impressive vocabulary test age of 7;6 in an otherwise seriously cognitively impaired individual is not the same as the normal child's word learning at the same chronological age. Nor is WS syntactic processing normal. For instance, Neville and collaborators have shown that event related potentials of WS adults with fluent language display different spatial and temporal patterns in language processing (Neville, Mills

& Lawson, 1992). Other psycholinguistic studies of WS have also shown unusual patterns in which the WS group show serious difficulties with an aspect of morphosyntax that normal children acquire effortlessly at about three years of age (Karmiloff-Smith *et al*., 1997) or show sensitivity to some syntactic violations but not others whereas normal groups never show such within-syntax dissociations (Tyler *et al*., in press).

Our study has shown that, despite relatively good vocabulary levels, people with WS fail to obey some of the lexical constraints that guide the way normal children learn new words. Our results underline the fact that researchers should exercise caution in jumping to the conclusion that the atypically developing brain is necessarily a window on the normal brain and its purported modularity (e.g. Anderson, 1992; Smith & Tsimpli, 1995). It should always be borne in mind that equivalent behavioural outcomes (e.g. in vocabulary scores, syntactic performance etc.) can stem from different brain structures and processes.

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# APPENDIX 1

## EXPERIMENTAL ITEMS USED IN EXPERIMENT 1

*Familiar group*

| | |
|---|---|
| pencil | (non-shiny) |
| cork | (non-shiny) |
| rubber | (non-shiny) |
| pen | (non-shiny) |
| key | (shiny) |
| pencil sharpener | (shiny) |
| padlock | (shiny) |
| whistle | (shiny) |

*Unfamiliar group*

| | |
|---|---|
| incense holder | (non-shiny) |
| guitar bottleneck slide | (non-shiny) |
| guitar plectrum | (non-shiny) |
| Christmas tree light cover | (non-shiny) |
| poster frame clip | (shiny) |
| icing bag nozzle | (shiny) |
| video cable junction socket | (shiny) |
| video ‘C’ cable plug | (shiny) |

## APPENDIX 2

### NOVEL NAMES USED IN EXPERIMENT 1

| *Monosyllabic* | *Bisyllabic* |
|---|---|
| PRINK | FRICKLE |
| SHAP | ROPPER |
| CLUD | VENICK |
| PRAST | DREVER |
| YIVE | CORSHTER |
| ZONK | HOCKREE |
| LEK | PUGBAH |
| BIV | FELDER |

## APPENDIX 3

### ITEMS USED IN EXPERIMENT 2

| *Condition* | *Object* | *Part* |
|---|---|---|
| *For younger controls* | | |
| Familiar part | mouse | tail |
| | house | chimney |
| | leg | foot |
| | car | wheel |
| | camel | hump |
| | bottle | top |
| | television | screen |
| | bird | beak |
| Unfamiliar part | fish | dorsal fin |
| | horse | fetlock |
| | light bulb | tungsten |
| | door | lintel |
| | camera | f-ring |
| | eye | iris |
| *For older controls and individuals with Williams syndrome* | | |
| Familiar part | mouse | tail |
| | house | chimney |
| | leg | foot |
| | car | wheel |
| | camel | hump |
| | bottle | top |
| | television | screen |
| | bird | beak |



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| | | |
|---|---|---|
| Unfamiliar part | spanner | ratchet |
| | horse | fetlock |
| | light bulb | tungsten |
| | door | lintel |
| | camera | f-ring |
| | eye | iris |

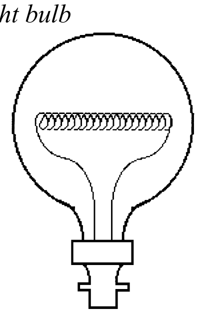
## APPENDIX 4

FAMILIAR OBJECT
*Bird*

FAMILIAR PART
*Beak*

FAMILIAR OBJECT
*Light bulb*

UNFAMILIAR PART
*Tungsten*



## APPENDIX 5

EXPERIMENTAL ITEMS USED IN EXPERIMENT 3

| *Condition* | *Object* | *Part* |
|---|---|---|
| Familiar | mouse/rat | tail |
| | house | chimney |
| | leg | foot |
| | car | wheel |
| | camel | hump |
| | bottle | top |
| | television | screen |
| | bird | beak |

| | | |
|---|---|---|
| Unfamiliar | cafetière | plunger |
| | hygrometer | ballast |
| | embryo | radicle |
| | portico | ionic (column) |
| | pagoda | finial |
| (normal controls) | lung | bronchiole |
| (Williams syndrome group) | amoeba | pseudopod |

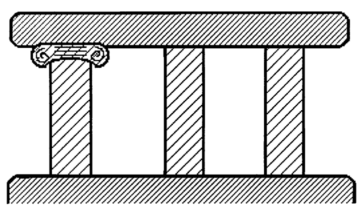
## APPENDIX 6

FAMILIAR OBJECT
*Mouse*

FAMILIAR PART
*Tail*

UNFAMILIAR OBJECT
*Portico*

UNFAMILIAR PART
*Ionic* (*Column*)





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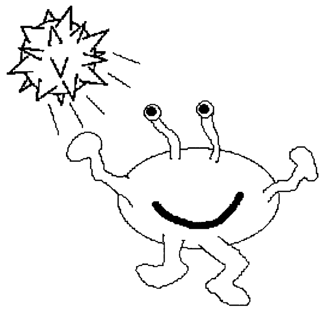
## APPENDIX 7

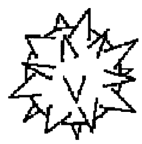
*Stimulus picture*



*'ball' in pink, Mr Carefree in green*

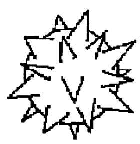
*Description*

*'It's playing with this. And it could play with anything else, couldn't it?'*



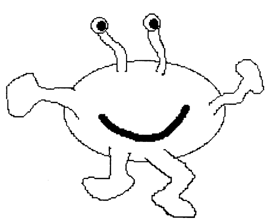
*'ball' in green*

*Taxonomic choice picture*



*'ball' in pink*

*Thematic choice picture*



*Mr Carefree in green*



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## APPENDIX 8

NOVEL WORDS USED IN EXPERIMENT 4

| *Monosyllabic* | *Bisyllabic* |
| --- | --- |
| PRINK | FRICKLE |
| SHAP | ROPPER |
| CLUD | VENICK |
| PRAST | DREVER |
| YIVE | CORSHTER |
| ZENK | HOCKREE |
| LEK | PUGBAH |
| BIV | FELDER |