J. Child Lang. **32** (2005), 175–189. DOI: 10.1017/S0305000904006610

NOTE

'Word-learning wizardry' at 1;6*

CARMEL HOUSTON-PRICE
School of Psychology, University of Reading

KIM PLUNKETT
Department of Experimental Psychology, University of Oxford

AND

PAUL HARRIS
Graduate School of Education, Harvard University

(*Received* 29 *September* 2003. *Revised* 4 *May* 2004)

ABSTRACT

This article explores whether infants are able to learn words as rapidly as has been reported for preschoolers. Sixty-four infants aged 1;6 were taught labels for either two moving images or two still images. Each image–label pair was presented three times, after which comprehension was assessed using an adaptation of the intermodal preferential looking paradigm. Three repetitions of each label were found to be sufficient for learning to occur, fewer than has previously been reported for infants under two years. Moreover, contrary to a previous finding, learning was equally rapid for infants who were taught labels for moving versus still images. The findings indicate that infants in the early stages of acquiring a vocabulary learn new word-referent associations with ease, and that the learning conditions that allow such learning are less restricted that was previously believed.

INTRODUCTION

The ease and speed with which young children acquire the vocabulary of the language in which they are raised is an impressive feat of development.

[*] The first author was supported by a Medical Research Council Research Studentship while carrying out this research. We would like to thank the Oxford parents and toddlers who participated in this study. Address for correspondence: Dr Carmel Houston-Price, School of Psychology, University of Reading, Earley Gate, Whiteknights, PO Box 238, Reading RG6 6AL, UK. e-mail: c.houston-price@reading.ac.uk

Between birth and 6;0, the meanings and uses of up to 14,000 words are learned, an average of five new words each day (Smith, 1926; Templin, 1957; Anglin, 1993). The origins of this ability are often claimed to lie in developments that occur during the vocabulary spurt, a period of marked growth in the child's production of new words that is usually seen towards the end of the second year (Benedict, 1979; Goldfield & Reznick, 1990).

Early research into children's ability to rapidly form associations between words and their meanings therefore focused on children aged between two and five years, an age described by Carey (1978) as a period of 'word-learning wizardry'. Anecdotal evidence suggesting that preschoolers sometimes acquire new words at home after hearing their parents speak them only once led researchers to investigate whether equally rapid learning could be elicited in experimental settings. A number of such studies showed that, when a new word was explicitly contrasted with a familiar word, young children could FAST MAP the new word to its meaning on the basis of only one or two exposures (e.g. Carey & Bartlett, 1978; Heibeck & Markman, 1987). For example, Carey & Bartlett (1978) found that three- and four-year-olds mapped the word *chromium* to a novel colour when the word was presented in a sentence frame such as *Bring me the chromium tray. Not the blue one, the chromium one*. Dollaghan (1985) similarly reported that two- to five-year-olds showed some understanding of a new word that they had heard used once to refer to a novel object. While these studies do not address how the child proceeds to acquire a full understanding of the scope of a word's reference, a process which may take a considerable period of time, they demonstrate nonetheless that the initial linkage between a word and its meaning can be laid down rapidly and with ease by preschoolers.

Recent developments enabling researchers to assess word knowledge in even younger children have revealed that a considerable number of word meanings are learned prior to the preschool period. British parents report comprehension vocabularies of between 50 and 250 words for infants aged 1;6 on the Oxford Communicative Development Inventory (CDI; Hamilton, Plunkett & Schafer, 2000), a British English version of the MacArthur CDI (Fenson, Dale, Reznick, Bates, Thal & Pethick, 1994). Furthermore, infants as young as 0;6 and 0;7 have been shown to demonstrate some understanding of labels for familiar people, objects and events both in observational studies (Harris, Barlow-Brown & Chasin, 1995; Harris, Yeeles, Chasin & Oakley, 1995) and in controlled laboratory conditions (Tincoff & Juszcyk, 1999), suggesting that the mechanisms required for the early stages of vocabulary development are present at a very young age. Researchers have therefore attempted to find evidence of rapid word learning, similar to that shown by preschoolers, in even younger children (e.g. Oviatt, 1980; Luciarello, 1987; Woodward, Markman & Fitzsimmons, 1994; Schafer & Plunkett, 1998; Werker, Cohen, Lloyd, Casasola & Stager, 1998).

However, many of the earlier studies that claimed to demonstrate rapid word learning in infants under two years have been criticized for the manner in which they assessed infants' comprehension of the newly-taught words. Such studies often failed to control for infants' spontaneous preferences or response biases when requiring them to identify a named referent from among two or more items at test. For example, infants might be presented with two objects, only one of which had previously been seen or labelled. Alternatively, the target might always be the more attractive of two items presented at test, or might always be presented on the same side. It is clear that such designs allow infants' non-linguistic strategies, preferences and response biases to be confounded with their understanding of the words of interest (see Schafer & Plunkett, 1998 for more). Clark (1973) therefore advocates that comprehension tests measure infants' baseline preferences alongside their understanding of the newly-taught words.

Research in this area has also been hindered by the difficulty of measuring comprehension in children who are too young to show their understanding by means of an overt behavioural or verbal response. Recent discoveries regarding early word learning therefore owe much to the development of experimental techniques that enable infants' linguistic knowledge to be assessed in a controlled manner. For example, in the intermodal preferential looking paradigm (IPL), an infant is shown two images simultaneously while hearing the name for one of them. It has been found that comprehension of the spoken label frequently causes the infant to look longer at the appropriate referent, the TARGET, than at the inappropriate referent, the DISTRACTER. The IPL has been successfully used to detect comprehension in children from six months to three years of age (Thomas, Campos, Shucard, Ramsay & Shucard, 1981; Golinkoff, Hirsh-Pasek, Cauley & Gordon, 1987; Behrend, 1988; Reznick, 1990; Reznick & Goldfield, 1992; Poulin-Dubois, Graham & Riddle, 1995; Fernald, Pinto, Swingley, Weinberg & McRoberts, 1998; Schafer & Plunkett, 1998; Swingley, Pinto & Fernald, 1998; Meints, Plunkett & Harris, 1999; Tincoff & Jusczyk, 1999).

Schafer & Plunkett (1998) used the IPL paradigm to teach infants aged 1;3 two novel names (*bard* and *sarl*) for two novel images. During an initial training phase, each image was presented with its label six times. In a subsequent test phase, infants were shown both images simultaneously while they heard the name for one of them. The training and test blocks were then repeated, and the amount of time infants spent looking at the target and distracter images was collapsed across the two test blocks. Schafer & Plunkett found that infants looked longer at target images than distracter images during test trials, both in terms of the total amount of time they spent fixating each image and in terms of their longest looks towards each image, although the latter measure was found to be more sensitive to

infants' learning. Schafer & Plunkett's results therefore provide evidence that, given a dozen exposures to new word–image pairings, infants can rapidly form new word-like associations during the first half of the second year.

Werker *et al.* (1998) obtained a similar result using the HABITUATION SWITCH TASK, which like the IPL uses infants' looking times as an index of their understanding of a spoken word. Werker *et al.* habituated infants aged 0;8, 1;0 and 1;2 to two word–object pairs by presenting them with between 8 and 10 pairings of each. After this habituation phase, infants were presented with either a SAME pairing, one that they had already been exposed to, or a SWITCH pairing, when one object was presented in association with the word that had been paired with the other object during habituation. In this paradigm, a difference between infants' looking times to the same and switch pairs is taken as evidence that they have learned the word–object associations during training. While Werker *et al.* found that 10 exposures to each pair were insufficient for the younger two groups to learn the associations, the oldest infants (aged 1;2) did demonstrate such a fast mapping capacity. However, this ability was qualified by the experimental condition and by the gender of participants. When the new words' referents moved during habituation, infants rapidly acquired their labels. When infants were provided with labels for still objects, no learning was seen. In addition, while the girls in the oldest group showed robust learning across two studies in which moving objects were presented, boys showed evidence of learning in only one study, suggesting that the fast mapping capacity may have been less robust for the boys.

The studies reported by Werker *et al.* (1998) and Schafer & Plunkett (1998) are noteworthy for a number of reasons. First, they show that mappings between words and referents can be formed in highly controlled conditions, and in the absence of any social interaction with the speaker. The social environment in which the vast majority of a child's vocabulary is acquired undoubtedly provides the young word learner with a rich source of information about the appropriate mappings to form, and numerous studies have shown that children are highly sensitive to cues provided by their social partners (e.g. Baldwin, 1991, 1993, 1995; Tomasello, Strosberg & Akhtar, 1996; Moore, Angelopoulos & Bennett, 1999). However, the more extreme claim has been made that word learning cannot occur outside of situations of communicative interaction (Akhtar & Tomasello, 2000). Demonstrations of learning in controlled laboratory conditions show that a number of vital components of the word learning process – such as the building of representations of the word form and referent and the formation of an associative link between them – can indeed occur in the absence of any social interaction.

The studies reported by Werker *et al.* (1998) and Schafer & Plunkett (1998) are also important for revealing that, even without such social

support, infants are capable of mapping word forms to objects or images long before they reach the period of 'word-learning wizardry' proposed by Carey (1978). However, it remains unclear whether infants under two years of age are able to demonstrate the very rapid learning that has been shown by preschoolers after only a couple of exposures to the pairings to be learned. The experiment reported here used the IPL to explore whether infants aged 1;6 could fast map two novel words to two images on the basis of only three exposures to each pairing. In order to optimize the likelihood of uncovering infants' true learning potential, every attempt was made to reduce the unnecessary cognitive demands of the task. To this end, the referents to be associated with the novel words were selected to be both highly salient and highly familiar to infants, and the word forms were selected to be distinctive. In addition, this study examined whether, for infants of this age, fast mapping requires the referents for which labels are to be learned to move during training. On the basis of the findings of Werker *et al.* (1998), it was expected that learning would be shown in a moving image condition but not in a still image condition. Finally, the possibility that rapid learning might be elicited more easily from girls than boys was investigated.

METHOD

Design

Infants were taught two new labels for two familiar but name-unknown images. For half of the infants, these were moving video clips throughout the study, for half they were still images. Following the training phase, in which each new label was presented simultaneously with its referent three times, infants were presented with a block of test trials, during each of which both images were presented and the name for one was heard. Learning was expected to be shown in longer looking towards the matching image (the target) on test trials.

During both blocks infants were also presented with word–image pairings that were expected to be known to them prior to the study. These familiar word trials were included to maintain participants' interest by increasing the variety of auditory and visual stimuli experienced, and to alert infants to the referential relationship between the words and images presented.

Participants

Sixty-four healthy infants aged 1;6 (range 1;5–1;7) were recruited from the Oxford BabyLab database of infants whose parents had volunteered to participate in a study with their child. Infants were randomly assigned to one of two experimental conditions, so that 32 infants (17 boys and 15 girls;

mean age 1;6.15) participated in the still image condition and 32 infants (18 boys and 14 girls; mean age 1;6.24) participated in the moving image condition. Five infants failed to complete the study (three in the still image condition, two in the moving image condition); their data were excluded from analyses. Infants were accompanied by a caregiver, usually the mother, and were given either a BabyLab T-shirt or travel expenses as a reward.

Materials

Visual stimuli. The images used in this study were video clips and snapshots taken from the BBC television programme *Teletubbies*. At the time of the study, *Teletubbies* was shown daily on children's television and was extremely popular with children aged 1;0–3;0. All except one of our participants were reported to have seen the programme by their caregiver. Four video clips were selected from the programme, each depicting a single, highly familiar object moving continuously against a colourful background of green, flower-covered hills and a cloud-filled sky. Two clips depicted objects for which no labels were expected to be known: a windmill with spinning sails that emitted pink lights, and a showerhead that rose from the ground while rotating. Both of these are shown during every episode of *Teletubbies* and would have been familiar to infants, yet neither is ever labelled during the programme. The other two video clips that were selected depicted a cartoon bear and a laughing baby, items whose labels would be expected to be known at 1;6, according to frequency counts of reported comprehension provided by the LEX database (Dale & Fenson, 1993) and the Oxford CDI database (Hamilton *et al*., 2000). Five-second video clips of each moving object were captured using Broadway Video Capture and still images were created by taking a snapshot from each video. Both image types measured 352 × 288 pixels (29 × 24 cm on screen). The still images can be seen in Figure 1.

Auditory stimuli. The novel words *shoofy* and *gopper* were used as training stimuli in this study for the following reasons. First, the words are highly dissimilar and share no phonemes in common, which should facilitate discrimination of their sounds. Second, the words are extended by the addition of a final vowel or schwa to make the internal consonant more salient. This addition was also expected to make the words more appealing to infants, as similar alterations of monosyllabic English words are commonly seen in both infant-directed speech and in children's productions (e.g. *horsie*, *Dadda*). Finally, the words obey the rules of English phonology and were spoken with the trochaic (strong–weak) stress pattern that is typical of English bisyllabic words, and preferred by infants exposed to the English language.

Fig. 1. The two name-known (*bear* and *baby*) and name-unknown images.

Words were digitally recorded by a female, native English speaker in a soundproofed room at 22 050 Hz, using 16-bit mono sampling. Words were recorded in citation form (*Look!*, *Baby!*, *Bear!*, *Shoofy!*, and *Gopper!*) using infant-directed speech. Speech samples were extracted from the digital tape using Cool Edit '96 and Goldwave was used to normalize volume levels and filter out background noise. The word *Look!* was inserted into each naming sample, so that the onset of the word *Look!* preceded the onset of the target word by exactly 2300 ms.

Apparatus. The experiment was conducted in semi-darkness in Oxford BabyLab's preferential-looking booth. Images were displayed on the left and right sides of a large back-projection screen, separated by a distance of 30 cm. A loudspeaker situated centrally above the screen delivered the auditory stimuli. A small red light and buzzer mounted above the centre of the screen were used to centre infants' attention between trials. Looking times towards each image were recorded by hidden video cameras positioned above each of the image locations.

Procedure

Infants sat on their caregiver's lap approximately one metre in front of the screen. The adult was asked to close her eyes and listen to classical music over headphones, to prevent her from influencing her child's behaviour.

Infants were presented with a series of 14 trials (eight training trials and six test trials) with a total duration of around two minutes. The timing of training and test trials was identical. Visual images were presented for 5000 ms. The word *Look!* was heard after 200 ms and the target word began after 2500 ms. Trials were therefore divided into pre- and post-naming periods of equal length, allowing the impact of hearing the target word over and above infants' baseline looking preference to be ascertained for each trial. Trials were initiated by an experimenter in an adjacent control room only when the infant was attending to the screen. The light and buzzer were used to attract infants' attention between trials when necessary.

Each infant saw either moving video clips or still images during every trial, according to the condition to which they had been assigned.

Training phase. The training phase consisted of eight trials, each presenting a single image in association with its label. The first two trials were familiar word trials. Infants saw the video or still image of one of the name-known images on one side of the screen and heard its label on one of the trials, and then saw the video or still image of the other name-known image on the other side of the screen and heard the label for that image on the second trial.

The following six trials were novel word training trials. Infants saw each of the name-unknown images three times, twice on one side of the screen and once on the other side. On each trial, the appropriate novel word was heard, in the format, *Look! … Shoofy!* The assignment of the two novel words to the two name-unknown images was counter-balanced: half of the infants in each condition were taught that *gopper* was the windmill-like object and *shoofy* was the showerhead-like object, and half *vice versa*. The side on which each image was presented more often during training was counter-balanced between infants in each condition, and the order in which the six training trials were presented was randomly determined by the presentation software.

Test phase. The training phase was immediately followed by six test trials, during each of which infants saw two images simultaneously on screen and heard the name for one of them, again in the form *Look! … Shoofy!* Infants were presented with two familiar word trials followed by four novel word test trials. On familiar word trials, the two name-known images were presented; each image was labelled during one of the two trials. On novel word trials, the two name-unknown images were presented; each image was labelled twice, once when presented on the left

side of the screen, once when presented on the right. The order of presentation of novel word test trials was randomized by the presentation software.

Scoring. Infants' looks towards each side of the screen were recorded during novel word test trials. Looking times were scored off-line using a button-press apparatus to indicate whether the infant was looking towards the left or right monitor or neither. The scorer was blind to the side of the target image. Each trial was scored four times, twice for looking at the left monitor and twice for looking at the right monitor, and the first and second sets of scored times were averaged.

Intra-scorer reliability was assessed by computing Pearson's correlation coefficients between the first and second sets of scored times for a random sample of 20% of infants ($N=12$). Mean reliability for these infants was $r=0{\cdot}99$ (range: 0·94–1·00).

RESULTS

Following Schafer & Plunkett (1998), who found infants' longest looks to be the most sensitive measure of their comprehension of a newly-learned word, the index of preferential looking reported here is the difference between infants' single longest looks towards the target and distracter images. This measure of target preference was calculated for the pre- and post-naming periods of each novel word test trial and averaged across infants in each condition. Learning of the word–image associations was expected to be shown in an increase in preference for the target image from the pre- to post-naming periods of test trials.

Infants' target preferences before and after hearing the target word on novel word test trials can be seen in Figure 2. It can be seen that the looking behaviour of infants in both the moving image and still image conditions changed on hearing the target word. In both conditions, infants showed random looking towards the two images during the baseline or pre-naming part of each trial, and then looked longer at the target on hearing its label. To explore whether these looking patterns indicate that word–image associations had been learned by infants in either or both conditions and by one or both gender groups, the data were entered into a $(2)\times(2)\times(2)$ mixed analysis of variance with two between-subjects factors, each with two levels (condition and gender) and one within-subjects factor (pre- vs. post-onset of target word). The analysis found a main effect of onset of target word, $F(1,55)=7{\cdot}23$, $p<0{\cdot}01$. Infants looked longer at targets relative to distracters after they had been named than they did before they had been named. There were no effects of condition, $F(1,55)=0{\cdot}15$, $p>0{\cdot}05$, or gender, $F(1,55)=0{\cdot}06$, $p>0{\cdot}05$, and there were no interactions between the factors. Infants increased their fixation of the target image on hearing it

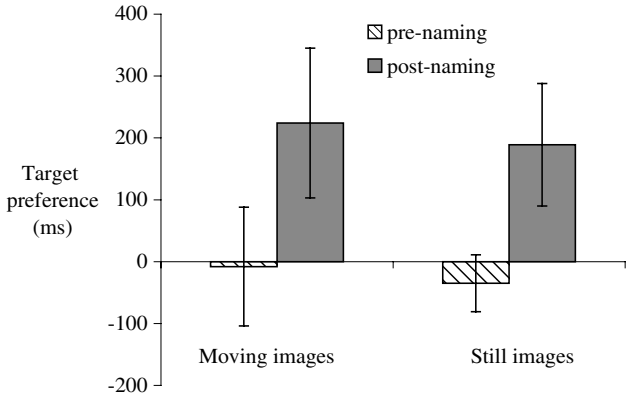

Fig. 2. Mean target preferences (and standard errors) for infants in each condition before and after hearing target words. Target preference is the difference between infants' longest looks towards the target and distracter images.

named regardless of their gender or the condition to which they had been assigned. An independent samples *t*-test comparing the moving and still image groups' mean change in target-preference on hearing the target word confirmed that the size of the onset of target word effect was equivalent across the two conditions, $t(57) = 0{\cdot}05$, $p > 0{\cdot}05$ (moving image group: mean change = 232 ms, *S.D.* = 623 ms; still image group: mean change = 224 ms, *S.D.* = 678 ms).

DISCUSSION

This study provides evidence of extremely rapid word learning by infants aged 1;6. After only three training trials pairing two novel words with two name-unknown images, infants significantly increased their looking towards named targets on testing. Moreover, no differences in learning were found between male and female participants, or between infants who were taught labels for moving images and those who were taught labels for still images.

Word learning on the basis of only three training trials reveals considerably more wizardry during the second year than the infancy literature would lead one to expect. While ONE-SHOT MAPPING has been reported in children aged between 2;0 and 5;0 (Dollaghan, 1985), previous successful demonstrations of word learning in one-year-olds have presented many more than three trials per new word. The rapid learning shown in the current study is all the more noteworthy considering that infants were simultaneously taught two new words, while many of the early studies taught only one. For example, Woodward *et al.* (1994) provided their infants with nine repetitions of a single novel label for a single object. In studies that have

taught two new words, the numbers of training trials have been equally large. Schafer & Plunkett (1998) reported preferential fixation of the target only after their infants had received 12 pairings of each word and referent. In Werker *et al.*'s (1998) habituation-switch task, which might be expected to place fewer cognitive demands on infants than a preferential looking task, evidence of learning was found after 8 to 10 exposures to objects and their labels. It is of course possible that these studies might have discovered more rapid learning had they tested infants' comprehension after fewer exposures. However, it is equally possible that infants might have shown earlier comprehension of the novel words in the current study, had they been tested after only one or two training trials. Future studies should endeavour to ascertain the minimum number of presentations required for this type of learning during the second year.

Nonetheless, it remains that the learning reported in this paper is considerably more rapid than any that has been reported to date for infants of this age. Infants' success here demands consideration of whether features of the learning situation that were specific to the current study might have facilitated their learning. According to associative accounts of word learning, the construction of associations between words and objects crucially depends on infants' attention to the stimuli to be paired (Samuelson & Smith, 1998; Smith, 2000). The associative account therefore predicts that stimulus salience should have a powerful influence on infants' learning. The current study attempted to ensure that both auditory and visual stimuli were highly salient for infants. In terms of the auditory stimuli, word forms were highly distinctive bisyllabic words that sounded like the names of children's toys. This is not the case in all previous research. For example, Schafer & Plunkett (1998) required infants to attach the similar-sounding words *bard* and *sarl* to novel images.

A number of properties of the visual stimuli may also have facilitated infants' learning by making them especially salient. First, all participants except one were reported to have seen *Teletubbies* and would therefore have been familiar with the images shown, as they appear during every episode of the programme. Moreover, infants' previous experience with these images would have occurred in a very similar context, on a television screen. While previous experience with referents is clearly not a prerequisite for word learning, as Schafer & Plunkett's (1998) infants demonstrated when they learned labels for entirely novel images, it may be a factor in the extremely rapid learning that was seen in the current study. It could certainly be argued that laboratory tasks of the type employed by Schafer & Plunkett (1998) place a considerably greater cognitive load on the infant than does real-life word learning. In order to learn associations between unfamiliar objects and unfamiliar labels infants must build representations of each new word and object in addition to the mapping between them. However, in real

life word learning situations, children will often have had a great deal of experience with referents before learning their labels, and will therefore have a prior representation of the referent onto which a new label can be mapped. While no research to date has systematically examined this issue, it is often implicitly accepted that familiarizing infants with new referents prior to presenting their labels will facilitate learning (e.g. Hirsh-Pasek, Golinkoff & Hollich, 2000). A key role for referent familiarity in early word learning is further supported by observational and experimental studies of vocabulary development which suggest that infants' earliest words refer to people, objects and events with which they are highly familiar (e.g. Harris & Chasin, 1999; Tincoff & Jusczyk, 1999).

The complexity and colourfulness of the visual stimuli used in this task may also have speeded the acquisition of their labels. While Schafer & Plunkett's (1998) images comprised 'at least two spectral colors and two textures', they were presented against a white background. Werker *et al.* (1998) similarly selected their stimuli to be salient for infants but presented them against a plain black background. In the current study, colourful objects were presented against a multi-coloured, highly detailed background, which may have encouraged visual exploration by infants, which in turn may have enabled more rapid learning.

By the same logic, the associative perspective would predict that an object's movement should make it more salient and thereby facilitate the learning of its label. Infants are known to prefer moving stimuli over otherwise identical stationary stimuli from birth (Slater, Morison, Town & Rose, 1985) and object movement is frequently equated with object salience in the word learning literature (e.g. Moore *et al.*, 1999). In this study, however, infants did not appear to require or benefit from movement when attaching a new label to an image. Infants increased their fixation of named targets by an equal amount irrespective of whether the visual stimuli were moving or stationary.

This finding conflicts with that of Werker *et al.* (1998), whose infants aged 1;2 learned names for moving objects but showed no learning when the same objects were stationary. This discrepancy might be explained by a number of differences between the two studies. The first and least interesting possibility is that the discrepancy is simply a result of differences in the manner in which the habituation-switch task and preferential looking task assess learning. That is, infants might find it easier to dishabituate to mismatching word–object pairings when the objects are moving because of attentional factors that are specific to the habituation paradigm.

A second account of the discrepancy between Werker *et al.*'s (1998) findings and those of the current study relates to the differing ages of the participants in the two studies; infants of 1;2 might be unable to rapidly acquire labels for stationary objects while older infants of 1;6 manage this

task with ease. Further research is clearly needed both to ascertain the age at which infants first demonstrate the ability to fast map words and images and to follow the development of this ability over time to discover whether image movement ceases to be useful at a certain age or vocabulary level.

A third possible explanation of the discrepancy in findings, and one that is compatible with an associative learning account of infants' behaviour in these studies, is that successful word learning during the second year depends on the global salience of the referent, and once this reaches a criterial value, additional manipulations of salience fail to further facilitate learning. Infants' success in both conditions in the current study might thus be explained by their intense interest in colourful, complex and familiar images, to which the addition of movement made little difference. If Werker *et al.*'s (1998) stimuli had a lower baseline salience level for infants, the manipulation of the objects' movement may have facilitated infants' learning for the same reason that learning was so rapid in both conditions in the current study.

These hypotheses clearly require exploration if the predictions of the associative learning perspective are to be tested more fully. The data nevertheless speak clearly to the fact that, even in a learning context bereft of communicative interaction, infants aged 1;6 are able to take the first steps in building a vocabulary with ease.

REFERENCES

Akhtar, N. & Tomasello, M. (2000). The social nature of words and word learning. In R. M. Golinkoff, K. Hirsh-Pasek, L. Bloom, L. B. Smith, A. L. Woodward, N. Akhtar, M. Tomasello & G. Hollich (eds), *Becoming a word learner: a debate on lexical acquisition*. Oxford: Oxford University Press.

Anglin, J. M. (1993). Vocabulary development: a morphological analysis. *Monographs of the Society for Research in Child Development* **58** (10, Serial No. 238).

Baldwin, D. A. (1991). Infants' contribution to the achievement of joint reference. *Child Development* **62**, 875–90.

Baldwin, D. A. (1993). Infants' ability to consult the speaker for clues to word reference. *Journal of Child Language* **20**(2), 395–418.

Baldwin, D. (1995). Understanding the link between joint attention and language. In C. Moore & P. J. Dunham (eds), *Joint attention: its origins and role in development*. Hillsdale, NJ: Erlbaum.

Behrend, D. A. (1988). Overextensions in early language comprehension: evidence from a signal detection approach. *Journal of Child Language* **15**, 63–75.

Benedict, H. (1979). Early lexical development: comprehension and production. *Journal of Child Language* **21**, 85–123.

Carey, S. (1978). The child as word learner. In M. Halle, J. Bresnan & G. Miller (eds), *Linguistic theory and psychological reality*. Cambridge, MA: MIT Press.

Carey, S. & Bartlett, E. (1978). Acquiring a single new word. *Papers and Reports on Child Language Development* **15**, 17–29.

Clark, E. V. (1973). Non-linguistic strategies and the acquisition of word meanings. *Cognition* **2**(2), 161–82.

Dale, P. S. & Fenson, L. (1993). *LEX: a lexical development norms database* (*computer program*). Seattle, Washington: University of Washington, Department of Psychology.

Dollaghan, C. (1985). Child meets word: 'Fast mapping' in preschool children. *Journal of Speech and Hearing Research* **28**, 449–54.
Fenson, L., Dale, P. S., Reznick, J. S., Bates, E., Thal, D. J. & Pethick, S. J. (1994). Variability in early communicative development. *Monographs of the Society for Research in Child Development* **59**(5), No. 242.
Fernald, A., Pinto, J. P., Swingley, D., Weinberg, A. & McRoberts, G. W. (1998). Rapid gains in speed of verbal processing by infants in the 2nd year. *Psychological Science* **9**, 228–31.
Goldfield, B. A. & Reznick, J. S. (1990). Early lexical acquisition: rate, content and the vocabulary spurt. *Journal of Child Language* **17**, 171–84.
Golinkoff, R. M., Hirsh-Pasek, K., Cauley, K. M. & Gordon, L. (1987). The eyes have it: lexical and syntactic comprehension in a new paradigm. *Journal of Child Language* **14**, 23–45.
Hamilton, A., Plunkett, K. & Schafer, G. (2000). Infant vocabulary development assessed with a British Communicative Development Inventory. *Journal of Child Language* **27**, 689–705.
Harris, M., Barlow-Brown, F. & Chasin, J. (1995). The emergence of referential understanding: pointing and the comprehension of object names. *First Language* **15**(43), 19–34.
Harris, M. & Chasin, J. (1999). Developments in early lexical comprehension: a comparison of parental report and controlled testing. *Journal of Child Language* **26**(2), 453–560.
Harris, M., Yeeles, C., Chasin, J. & Oakley, Y. (1995). Symmetries and asymmetries in early lexical comprehension and production. *Journal of Child Language* **22**(1), 1–18.
Heibeck, T. & Markman, E. M. (1987). Word learning in children: an examination of fast mapping. *Child Development* **58**, 1021–34.
Hirsh-Pasek, K., Golinkoff, R. M. & Hollich, G. (2000). An emergentist coalition model for word learning: mapping words to objects is a product of the interaction of multiple cues. In R. M. Golinkoff, K. Hirsh-Pasek, L. Bloom, L. B. Smith, A. L. Woodward, N. Akhtar, M. Tomasello & G. Hollich (eds), *Becoming a word learner: a debate on lexical acquisition*. Oxford: Oxford University Press.
Luciarello, J. (1987). Concept formation and its relation to word learning and use in the second year. *Journal of Child Language* **14**, 309–32.
Meints, K., Plunkett, K. & Harris, P. L. (1999). When does an ostrich become a bird? The role of typicality in early word comprehension. *Developmental Psychology* **35**(4), 1072–78.
Moore, C., Angelopoulos, M. & Bennett, P. (1999). Word learning in the context of referential and salience cues. *Developmental Psychology* **35**, 60–8.
Oviatt, S. L. (1980). The emerging ability to comprehend language: an experimental approach. *Child Development* **51**, 97–106.
Poulin-Dubois, D., Graham, S. A. & Riddle, A. S. (1995). Salient object parts and infants' acquisition of novel object words. *First Language* **15**, 301–16.
Reznick, J. S. (1990). Visual preference as a test of infant word comprehension. *Applied Psycholinguistics* **11**, 145–66.
Reznick, J. S. & Goldfield, B. A. (1992). Rapid change in lexical development in comprehension and production. *Developmental Psychology* **28**, 406–13.
Samuelson, L. R. & Smith, L. B. (1998). Memory and attention make smart word learners: an alternative account of Akhtar, Carpenter & Tomasello. *Child Development* **69**, 94–104.
Schafer, G. & Plunkett, K. (1998). Rapid word learning by 15-month-olds under tightly controlled conditions. *Child Development* **69**(2), 309–20.
Slater, A. M., Morison, V., Town, C. & Rose, D. (1985). Movement perception and identity constancy in the new-born baby. *British Journal of Developmental Psychology* **3**, 211–20.
Smith, L. B. (2000). Avoiding associations when it's behaviorism you really hate. In R. M. Golinkoff, K. Hirsh-Pasek, L. Bloom, L. B. Smith, A. L. Woodward, N. Akhtar, M. Tomasello & G. Hollich (eds), *Becoming a word learner: a debate on lexical acquisition*. Oxford: Oxford University Press.
Smith, M. E. (1926). An investigation of the development of the sentence and the extent of vocabulary in young children. *University of Iowa Studies in Child Welfare* **3**, no. 5.

Swingley, D., Pinto, J. P. & Fernald, A. (1998). Assessing the speed and accuracy of word recognition in infants. In C. Rovee-Collier, L. P. Lipsitt & H. Hayne (eds), *Advances in infancy research*, Vol. 12. Stamford, Connecticut: Ablex.

Templin, M. (1957). *Certain language skills in children: their interrelationship*. Minneapolis: University of Minnesota Press.

Thomas, D. G., Campos, J. J., Shucard, D. W., Ramsay, D. S. & Shucard, J. (1981). Semantic comprehension in infancy: a signal detection analysis. *Child Development* **52**, 798–803.

Tincoff, R. & Jusczyk, P. W. (1999). Some beginnings of word comprehension in 6-month-olds. *Psychological Science* **10**(2), 172–5.

Tomasello, M., Strosberg, R. & Akhtar, N. (1996). Eighteen-month-old children learn words in non-ostensive contexts. *Journal of Child Language* **23**, 157–76.

Werker, J., Cohen, L. B., Lloyd, V. L., Casasola, M. & Stager, C. L. (1998). Acquisition of word–object associations by 14-month-olds. *Developmental Psychology* **34**, 1289–1309.

Woodward, A., Markman, E. & Fitzsimmons, M. (1994). Rapid word learning in 13- to 18-month-olds. *Developmental Psychology* **30**, 553–66.