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# The role of verbal labels on flexible memory retrieval at 12-months of age<sup>☆</sup>

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## ABSTRACT

The provision of verbal labels enhances 12-month-old infants' memory flexibility across a form change in a puppet imitation task (Herbert, 2011), although the mechanisms for this effect remain unclear. Here we investigate whether verbal labels can scaffold flexible memory retrieval when task difficulty increases and consider the mechanism responsible for the effect of language cues on early memory flexibility. Twelve-month-old infants were provided with English, Chinese, or empty language cues during a difficult imitation task, a combined change in the puppet's colour and form at the test (Hayne et al., 1997). Imitation performance by infants in the English language condition only exceeded baseline performance after the 10-min delay. Thus, verbal labels facilitated flexible memory retrieval on this task. There were no correlations between infants' language comprehension and imitation performance. Thus, it is likely that verbal labels facilitate both attention and categorisation during encoding and retrieval.

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## 1. Introduction

The ability to flexibly retrieve our memories across a range of situations is an important feature of the declarative memory system. Memory flexibility, or the ability to use pre-existing stores of knowledge to solve new problems, enables us to avoid costly or time consuming re-learning and to benefit from our past experiences. Across the first two years of life, studies using the deferred imitation procedure have demonstrated that the ability to flexibly retrieve memories across changes in the social and physical contexts, or changes in the target stimulus develops gradually (e.g., Hayne, Boniface, & Barr, 2000; Hayne, Barr, & Herbert, 2003; Hayne, MacDonald, & Barr, 1997; Herbert & Hayne, 2000a; Herbert, Gross, & Hayne, 2006; Learmonth, Lamberth, & Rovee-Collier, 2004; Learmonth, Lamberth, & Rovee-Collier, 2005). For example, within the puppet imitation task, 12-month old infants can reproduce the target actions shown on a puppet that differs in colour (Hayne et al., 1997) or form (Jones & Herbert, 2008) from the one present during the original demonstration after a 10 min delay, but not with a puppet that differs in both colour and form, or after a 24 h delay. In contrast, 18-month old infants can reproduce the target actions with a puppet that differs in both colour and form after a 24-h delay but not when the puppets are highly

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dissimilar (e.g., black/white cow, yellow/orange duck; Hayne et al., 1997). Thus, early memory flexibility appears to be determined in part, by the degree of changes to the central stimulus between learning and retrieval, and the length of the retention interval (also see Herbert & Hayne, 2000a).

Language cues have recently been identified as a powerful means by which to enhance flexible memory retrieval at young ages. Being able to spontaneously self-generate a label for a novel stimulus or a hiding location facilitates 2-year-old children's ability to transfer knowledge to a new situation (Miller & Marcovitch, 2011; Zimmermann et al., 2015), while memory flexibility at younger ages benefits from experimenter-generated labels (Herbert & Hayne, 2000; Herbert, 2011). For example, in Herbert (2011), 12- and 15-month old infants were shown the target actions with the puppet task accompanied by verbal labels for the object and actions (e.g., "Look, a puppet. Off. Shake. On") or no label during the demonstration. At the test 10 min later, the puppet was labelled again for infants in the verbal label condition only. Infants in both the label and no label conditions reproduced significantly more target actions with a puppet that differed in form (e.g., pale grey mouse at demonstration, pale grey rabbit at test) than baseline performance by infants in the control condition. Thus, infants were already showing some ability to generalise across a change in stimulus form after the short delay. Importantly, however, infants in the label condition reproduced significantly more target actions than infants in the no label condition. In other words, verbal labels enhanced performance above spontaneous flexible memory retrieval. Whether the same effect would be observed when task difficulty increases remains to be determined. Perhaps unsurprisingly, verbal labels do not facilitate infant abilities in all situations, such as when 15-month-olds are asked to transfer knowledge across a complex 2D to 3D action imitation task (Zack, Gerhardstein, Meltzoff, & Barr, 2013). However a unique feature of the puppet task is that task difficulty can be progressively increased by altering the colour, form, or colour and form of the puppet, providing an opportunity to examine the limits of the facilitative effects of language on infant memory abilities. In this study we consider whether verbal labels can facilitate infants' memory flexibility across a complex change, altering both the form and colour of the stimulus present at retrieval.

Although the body of research showing the facilitative effects of language cues on memory flexibility continues to grow, the mechanism for this effect remains unclear. One possibility is that verbal labels may facilitate flexible memory retrieval across changes in the target object by potentially facilitating categorisation of the target and test objects (for similar argument, see Jones & Herbert, 2009). Infant language comprehension begins around 8- to 10-months (Fenson et al., 1994) at which point verbal labels can influence categorisation (Westermann & Mareschal, 2014). Verbal labels can affect perceived object similarity and can help infants categorise perceptually dissimilar exemplars of objects into a single category (Plunkett, Hu, & Cohen, 2008; Waxman & Booth, 2003; Waxman & Braun, 2005). For example, Plunkett et al. (2008) presented 10-month old infants with a series of objects that differed on a number of features where values on one dimension could combine with the full range of values on other dimensions. Infants categorised the objects into two categories (long neck and short neck) shown by a visual preference for the object that averaged across all dimensions. In contrast, when given a single novel label (e.g., "dax") for the objects during the familiarisation phase, 10-month old infants categorised objects into a single category (Plunkett et al., 2008). Thus, in the imitation task, a label presented at demonstration and test may help infants form a single category for the demonstration and test puppets and facilitate memory retrieval across the stimulus change.

Alternatively, verbal labels may function to direct infant's attention to the relevant aspects of the learning task. Indeed, Taylor and Herbert (2014) found that 6-, 9- and 12-month old infants' attentional patterns during the puppet demonstration session were related to their ability to reproduce the target actions at test. Using an eye-tracker, Taylor and Herbert (2014) showed that infants distribute their attention more widely than adults when viewing the puppet task. Critically, greater attention to the person and less attention to the background were related to learning outcome on the task (Taylor & Herbert, 2014). Furthermore, studies have shown that 9- to 12-month old infants increase attention to objects that have been labelled compared to objects that have not (Balaban & Waxman, 1997; Baldwin & Markman, 1989). Thus, verbal labels may serve as an attention grabber during learning and at test.

The purpose of the present experiment was to determine whether verbal labels facilitate flexible memory retrieval via an attentional or categorisation mechanism. Twelve-month old infants were presented with a puppet that differed in both colour and form during the imitation test session following a live demonstration 10 min earlier. At this age, infants typically fail to reproduce the target actions when presented with a colour and form change puppet (Hayne et al., 1997). Some infants received *empty language* cues (no verbal label) whilst others received *language* cues (verbal label for object and actions) in either English or Chinese. The English language labels were used to determine whether language could scaffold learning and push infants into succeeding on the difficult flexible retrieval task. By 12-months of age infants can no longer discriminate between foreign-language phonetics (Best, McRoberts, LaFleur, & Silver-Isenstadt, 1995; Kuhl, Tsao, & Liu, 2003; Maye, Werker, & Gerken, 2002; Narayan, Werker, & Beddor, 2010; Werker & Tees, 1984) and mouth sounds alone are not sufficient to produce categorisation (Fulkerson & Haaf, 2003). Thus, the Chinese language labels were used to determine whether verbal information merely directs infant attention to the relevant aspects of the task.

We hypothesised that infants who receive *empty language* cues will fail to reproduce the target actions with the form and colour change puppet, consistent with prior work (Hayne et al., 1997). In contrast, we predicted that infants who receive *English language* cues would reproduce the target actions with the form and colour change puppet, consistent with both an attentional and categorisation mechanism. If infants in the *Chinese language* group do not perform above baseline then the categorisation mechanism will be supported. In contrast, if infants in the *Chinese language* condition do perform above baseline then the attentional mechanism will be supported. If the effectiveness of verbal labels can be explained by

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