Young children's referent selection is guided by novelty for both words and actions

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Abstract

Young children are biased to select novel, name-unknown objects as referents of novel labels (e.g., Markman, 1990) and similarly favour novel, action-unknown objects as referents of novel actions (Riggs, Mather, Hyde & Simpson, 2015). What process underlies these common behaviors? In the case of word learning, children may be driven by a novelty bias favouring novel objects as referents (Horst, Samuelson, Kucker & McMurray, 2011). Our study investigates this bias further by investigating whether novelty also affects children's selection of novel objects when a new action is given. In a pre-exposure session, 40, three- and four-year-olds were shown eight novel objects for one minute. In subsequent referent selection trials children were shown two pre-exposed and one super-novel object and heard either a novel name or saw a novel action. The super-novel object was selected significantly more that the pre-exposed objects on both word and action trials. Our data add to the growing literature suggesting that an endogenous attentional bias to novelty plays a role in children's referent selection and demonstrates further parallels between word and action learning.

Key Words; Referent selection, Novelty, Action-object mapping, Word-object mapping

Introduction

How children learn the meanings of words has received considerable attention over the last 40 years. Researchers have been keen to identify the processes involved in working out the referent upon hearing a new word, as well as the factors that give rise to long term retention (see Swingley, 2010 for a review). Carey and Bartlett (1978) were the first to show that four- to five-year old children could accurately determine the correct referent for a novel name, when contrasted with a familiar name (i.e., they asked children to get "the chromium tray, not the blue one, the chromium one"). Since then many studies have replicated this general finding where the child has to decide what the referent is between a choice of a novel and a familiar object (e.g. Golinkoff, Hirsh-Pasek, Bailey, & Wegner, 1992; Wilkinson, Ross & Diamond, 2003). Children have been observed to select the appropriate referent from around 15 to 17 months of age (Halberda, 2003; Markman, Wasow, & Hansen, 2003; though see Bion, Borovsky & Fernald, 2013).

One answer to the question as to how children successfully select the correct referent is that they are guided by linguistic word learning biases. One such bias is mutual exclusivity; children will reject an object as a potential referent if it already has a name (Markman, 1989, 1990). Another bias is the novel-name-nameless-category (N3C) principle; when given a novel label children will select a referent belonging to a nameless category (Mervis and Bertrand, 1994; Golinkoff, Mervis, & Hirsh-Pasek, 1994). Both of these biases require children to discriminate between objects which they can and cannot name. Whatever the bias the outcome is the same - children map novel words to novel, unnamed objects.

Recently however, attention has turned away from specific linguistic biases with researchers investigating the role that more domain general processes might play in referent selection. Researchers have investigated if referent selection relies on broader learning biases, such as attention to novelty (Mather & Plunkett, 2012; Horst et al, 2011), or social-pragmatic reasoning (Grassman, Stracke & Tomasello, 2009). That is, do the processes used in mapping words to objects extend beyond word learning? For example, Markson and Bloom (1997) report that three- to four-year-old children map linguistic facts to novel objects and retain them in much the same way as they do new words. More recently, Riggs et al. (2015) demonstrated that the processing involved in word-object mapping and

retention, also extends to action-object mapping. In the first of their studies they tested three- and four-year-olds' ability to use novel actions as well as words in a referent selection task. Children were shown both a familiar object (e.g., a cup) and a novel object and given a request using either a novel name (e.g., "pass me the koba") or a novel action ("pass me the object we do this with", where the experimenter performed a 'novel' action, such as rubbing the top of the left arm). Children selected the novel object in both the novel action and novel word conditions at significantly above chance levels, with no difference in performance between them. These findings added to a small literature reporting that children map and retain novel actions to novel objects (and specifically those actions employed to *use* the object)[1] as readily as they map and retain novel words (Childers & Tomasello, 2002, 2003; Hahn & Gershkoff-Stowe, 2010). For example, Childers and Tomasello (2002) investigated whether the impressive retention of word-object mappings extends to action-object mappings. They trained young children on novel nouns, verbs and actions associated with a novel object. They tested comprehension ("Which object can I do this with?" as the experimenter performed the novel action) at time intervals of one minute, one day, and one week. Memory for correct actions was very good for all time intervals and no different from memory for correct words. Taken together, this literature supports the view that there are parallels between novel action learning and word learning in young children, and that word learning relies on domain-general attentional and learning processes.

Riggs et al. (2015) concluded that children use novel action information (i.e., how that object is used) to select a novel referent. They also raised two possibilities as to the processing underlying this behaviour. First, children may have used their knowledge of objects and how they are used to select a referent. That is, they may have excluded the familiar object because they knew the action associated with its use (e.g., running a hairbrush through one's hair). In other words, a kind of mutual exclusivity bias for actions and objects. A second possibility is that children responded on the basis of the most novel

[1] A different literature (see e.g., Suanda & Namy, 2013) investigates children's mapping of symbolic gestures to novel objects, i.e., those actions/gestures that might *represent* the referent, and not the mapping of those actions employed to *use* the object which is the focus of the current study.

stimulus, and that an attentional bias to novelty drove behaviour in their referent selection task.

With regard to word learning, Horst, et al. (2011) conducted a study relevant to this issue. They investigated the role of novelty in word learning by presenting children with nameless objects varying in novelty. In their experimental paradigm they pre-exposed novel objects to children aged 24 months. After pre-exposure children were then presented with two pre-exposed (unnamed) objects and one completely new, 'super-novel' object. When given a new name children were more likely to select the super-novel object even though none of the objects had names. The authors concluded that referent selection in two-year-olds is driven by children's endogenous bias to novelty. Other researchers have also demonstrated that an attentional bias to novelty plays a role in referent selection (Mather & Plunkett, 2012; though see Graham, Turner & Henderson, 2005).

To further investigate the role of novelty in referent selection we brought together the work of Horst et al. (2011) and Riggs et al. (2015) to investigate whether novelty drives behaviour in referent selection tasks when children observe novel actions. Using the methodology of Horst et al. (2011) we presented children with three novel objects that varied in novelty (two pre-exposed versus one super-novel). If children employ a mutual exclusivity bias for actions, then we would expect them to choose equally between the three novel objects because none of them has a known associated action. If on the other hand, novelty drives behaviour then we would expect them to choose the super-novel object, as was found by Horst et al. (2011). We tested three- and four-year-olds consistent with the ages of children tested in previous action-object studies. Our participants were therefore older than those tested by Horst et al. (2011) allowing us to establish if the Horst et al. (2011) findings extend to older children. While children appear to be guided by an attentional bias at 2 years of age, older children might engage in more explicit reasoning about possible referents (Halberda, 2006).

Methods

Participants

Participants were 40 children aged between three years, two months and five years of age (*M* = 43 months), 24 boys and 16 girls. Twenty children (13 boys and 7 girls) were

randomly allocated to the novel word condition (*M* = 42months) and 20 children (11 boys and 9 girls) to the novel action condition (*M* = 44 months). Children were recruited from nurseries and primary schools in North Yorkshire. All children spoke English as a first language and the teacher/nursery manager reported that none had behavioral or educational problems.

Materials and stimuli

11 known objects and 16 novel objects were used for the experiment (see Fig. 1). The 11 known objects were a key, a spoon, a pen, a toothbrush, a mobile phone, a cup, a pair of scissors, a hairbrush, a small toy teapot, a zip, and a spinning top. The 16 novel objects consisted of a metal fan, a piston, a table foot, a stop connector, a three-way hose connector, a four-way radiator key, a pipe scraper, a plastic grip, a metal puncher part, a plastic part from a photocopier, a plastic spacer, a novel tea strainer, a door stop, a small watering top, a metal machine part, and a novel bottle opener. The teacher confirmed that the children were unlikely to have seen, or to know the names of, the novel objects. The teacher also confirmed that all children would be familiar with the names of the familiar objects and their associated actions.

Fig. 1 about here

In the novel word condition eight CVC non-words were used to name the novel objects; dupe, fode, pabe, roke, foo, cheem, dite, yok. These words are the same as those used by Horst et al. (2011) because they follow English phonological rules. In the novel action condition eight non-iconic actions were used; object circling around the head, object scraping across the table, rubbing the object on lower arm, performing a zig zag motion in the air with the object, tapping the object in the air in differing spatial locations, twisting the object on the end of the nose, pushing the object outwards with extended arm, and pushing the object across the chest and off the shoulder. It should be noted that all actions were performed without the object being in the experimenter's hand and the experimenter kept

the size of the hand consistent for each action (i.e., loosely closed fist) as if they were holding an object.

Procedure

The procedure followed that of Horst et al. (2011). Throughout the experiment children in both conditions were pre-exposed to eight of the novel objects (counterbalanced across children). In referent selection trials there were two pre-exposed objects and one super-novel object. Thus the independent variables were information type (word/action), and novelty (pre-exposed/super-novel). The dependant variable was selection frequency of the super-novel object.

Testing took place in a school/nursery environment and children were told that the experimenter needed their help to look at some objects. The child sat across the table from the experimenter.

Pre-exposure phase: Each session began with a pre-exposure phase in which the child was shown, and encouraged to pick up and look at, half of the novel objects (the other eight objects were used as super-novel objects). Pre-exposed objects were shown in two blocks of four objects. Objects were placed in a 2x2 box (31 by 23 cms) with each object occupying one quarter. Each child was given approximately 60 seconds to look at all the objects in the box and was encouraged by the experimenter saying 'have you looked at all the objects?' Given the time period (60 secs) and the size of the box, we thought it very likely that all of the children would have looked at all of the objects in the box. The objects used as pre-exposed objects were counterbalanced across children so that objects pre-exposed with one child became super-novel objects for the next child. No names or actions were given to any of the objects during the pre-exposure period. To ensure that children were not guided by the experimenter's interaction with the objects, there was minimal interference from the experimenter.

Warm-up phase: Two warm-up trials introduced children to the forced choice task and provided them with practice in choosing an object. On each trial two familiar, known objects were presented in two sections of the box nearest to the child. On each warm-up trial the experimenter put the tray of objects on the table and waited three seconds to give the child the opportunity to look at the objects. The experimenter then asked for the target

object and this differed by condition. In the word warm-up trial the experimenter asked for one of the target objects by using the known name of the object e.g. 'can you pass me the cup'. In the action warm-up trial the experimenter asked 'can you get me the one we do this with?' (while showing the action associated with that object, e.g., lifting the hand to the mouth (spoon)). Children were not praised by the experimenter, the experimenter merely said 'okay' or 'thank you'. The same two objects were presented on each warm-up trial but positions were pseudo-randomised (left/right) – warm up stimuli were not used again during the referent selection test trials.

Referent selection trials: There was a total of 11 referent selection trials. Three of these 11 trials included only familiar well-known objects and words/actions. These familiar, object-known trials were included to keep the child on track, and occurred after every second novel referent selection trial (e.g., trials three, six, and nine). In each of the eight novel referent selection trials children were shown two pre-exposed and one super-novel object. As with the warm-up phase, referent selection trials differed according to condition (action or word). In the novel word condition children were asked 'can you pass me the (novel word given)?' In the novel action condition children were asked 'can you pass me the object we do this (experimenter demonstrated a novel action) with?' The novel objects presented were counterbalanced across children and the position of the super-novel object was randomised (left, right, or middle) across trials. Across novel name/action conditions each child saw each pre-exposed object twice and each super-novel object once.

Coding: The experimenter recorded the children's responses onto a data sheet during the testing session. On all trials children were asked to pass the experimenter the object. If a child only pointed to an object the experimenter again asked the child to pass the object. All children made clear responses by passing the object to the experimenter throughout the experiment.

Results and Discussion

Depending on which condition they were assigned to, children responded on either eight novel word or eight novel action referent selection trials. In the novel word condition, children chose the super-novel object on 61% of trials, demonstrating a bias towards the super-novel object. Children chose this object significantly more than expected by chance

(33%), *M* = 60.85, *SD* = 24.67, *t*(19) = 5.04, *p* < .001, *d* = 1.13. In the novel action condition, children chose the super-novel object on 62% of trials, again demonstrating a bias towards the super-novel object. This object was chosen significantly more than expected by chance (33%), *M* = 62.10, *SD* = 14.89, *t*(19) = 8.73, *p* < .001, *d* = 1.95. An independent sample t-test confirmed that there was no significant difference between the word (*M* = .61, *SD* = .25) and action (*M* = .62, *SD* = .15) conditions (*t*(38) = -.194, *p =* .847*)*. Children clearly understood the procedure: on familiar word trials children chose the correct familiar object on 95% of trials, and on the familiar action trials they chose the correct familiar object 83% of the time.

We also checked for both gender and age effects. There were no differences between boys (*M* = .65, *SD* = .18) and girls (*M* = .54, *SD* = .21) in the rate of super-novel object selection (*t*(38) = 1.72, *p =* .108). Neither were there age effects: T-tests revealed that both younger and older children chose the super-novel object at above chance levels. In the novel action condition, children aged under 48 months (n = 12) chose the super-novel object on 64% of trials (*p* = .001) and children over 48 months (n = 8) chose it on 60% of trials (*p* = .001). In the word condition, children under the age of 48 months (n = 10) chose the super-novel object on 70% of trials (*p* = .002) and children over 48 months (n = 10) chose it on 51% of trials (*p* = .008).

Our findings demonstrate that in an ambiguous referent selection task, three- to four-year-old children select the super-novel object over two pre-exposed novel objects when they observe a novel action. They extend the findings of Riggs et al. (2015) where children selected novel, action-unknown objects as referents of novel actions, to demonstrate that a preference for novelty underlies this behavior. They also extend the findings of Horst et al. (2011): older children also select the super-novel object in a referent selection task with two other pre-exposed novel objects. Taken together our data add further support to the idea that there are parallels between action and word learning (Childers & Tomaselo, 2002, 2003; Hahn & Gershkoff-Stowe, 2010; Riggs et al., 2015). They also add to the growing literature suggesting that word learning relies on general attentional and learning processes rather than specific linguistic biases (Horst et al, 2011; Mather & Plunkett, 2012).

Future work

Having established that there are parallels in referent selection behavior for both actions and words, an obvious question is whether there are also parallels in how well these words and actions are retained. Riggs et al. (2015, Experiment 2) found that children retain action-object mappings in much the same way as they do word-object mappings. In their task children did not have to select from a choice of possible referents, but were given the mapping directly. In future work it would be interesting to compare retention of action/word-object mappings under conditions where children have to select the referent versus conditions where they are given the mapping directly. In a recent word learning study, Zosh, Brinster, and Halberda (2013) found that the competition between two referents (one known and one unknown) enhanced children's retention of word-object mappings compared to a condition with no competitors. It would be illuminating if such a finding also extended to action-object mappings.

Do we take our data to suggest that children never use biases such as mutual exclusivity or N3C in word learning? We think not. It seems likely that children use novelty as a rough heuristic in ambiguous situations (Horst et al., 2011). One possibility is that children's endogenous attentional bias to novelty aids referent selection, but linguistic knowledge helps consolidate new words into long-term memory (Zosh et al., 2013). Neither do we deny that children might use existing knowledge of how familiar objects are used to learn the actions associated with novel objects. Future work should investigate whether differences in relative familiarity at exposure affect long term retention for novel-action mappings as this has already been investigated with words (Kucker & Samuelson, 2012).

A final question for future work is to establish whether children's responses are *solely* driven by a pre-existing preference for the most novel object (a basic visual preference) or whether the presentation of a novel word or action *increases* interest in the novel object (over and above any basic visual preference). Under the former possibility, children would select the super-novel object in response to *any* preference question (e.g., which one would they like to play with?). Either way, it is significant that novelty strongly influenced children's referent selections. Our data suggest that merely being a nameless (or action-unknown) object is not sufficient for selection – an object also needs to be the most novel amongst its competitors (Horst et al., 2011). Word learning biases such as N3C and mutual exclusivity are, at a minimum, underspecified with regards to the role of novelty.

In sum, novelty plays a role in referent selection with novel actions in much the same way it plays a role in referent selection with novel words. Findings from future studies will allow us to establish how far action and word learning overlap and determine further the extent to which domain general processes play a role in word learning.

Acknowledgements

This research was funded by a University of Hull PhD studentship awarded to the first author. We would like to thank all the children who participated in this study.

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Figure 1. Familiar objects (top panel) and novel objects (bottom panel) used in the experiment