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# Object associations of early-learned light and heavy English verbs

**Josita Maouene**,
Grand Valley State University, USA

**Aarre Laakso**, and
University of Michigan – Dearborn, USA

**Linda B. Smith**
Indiana University, USA

## Abstract

Many of the verbs that young children learn early have been characterized as 'light.' However, there is no agreed upon definition of 'lightness' and no useable metric that could be applied to a wide array of verbs. This article provides evidence for one metric by which the 'lightness' of early-learned verbs might be measured: the number of objects with which they are associated (in adult judgment) or co-occur (in speech to and by children). The results suggest that early-learned light verbs and heavy verbs differ in the breadth of the objects they are associated with: light verbs have weak associations with specific objects, whereas heavy verbs are strongly associated with specific objects. However, there is an indication that verbs have narrower associations to objects in speech to children. The methodological usefulness of this metric is discussed as are the implications of the patterns of distributions for children's learning of common verbs.

### Keywords

CHILDES; heavy verbs; language acquisition; lexical co-occurrence; light verbs; semantic association; transitive

By many accounts, verbs are hard for children to acquire because their meanings are abstract and relational and require children to ignore the concrete and surface similarities of the relational events to which verbs refer (Gentner, 1978; Gilette, Gleitman, Gleitman, & Lederer, 1999; Gleitman, 1990; Pinker, 1987; Snedecker & Gleitman, 2004). However, some common verbs seem more abstract and some less abstract than others (Clark, 1978; Gentner, 1978; Ninio, 1999a; Pinker, 1989; Tardif, 1996). With respect to these differences, theorists of English verb acquisition often distinguish 'light' and 'heavy' verbs. 'Light' verbs, such as *do*, *make*, *get*, *take*, and *go* are more abstract and label a wide range of specific events that have little in common, other than the relation itself. 'Heavy' verbs, such as *kick*, *eat*, *drink*, and *read* seem more concrete and specific and may refer to a smaller range of events, often ones that involve narrow classes of actions and objects



Corresponding author: Josita Maouene, Psychology Department, Grand Valley State University, 2105 Au Sable Hall, 1, Campus Dr., Allendale, MI 48401, USA. maouenej@gvsu.edu.

If the abstract nature of verb meanings is what makes their acquisition difficult for children, one might think that English 'heavy' verbs, being more concrete, would be learned earlier than English 'light' verbs. Contrary to this idea, English 'light' verbs are highly frequent and are among the earliest produced English verbs. Indeed, it has been proposed that these verbs serve a 'pathbreaking' role in verb and grammatical learning (Ninio, 1999a, 1999b; Theakston, Lieven, Pine, & Rowland, 2004). Consistent with this idea, Clark (1978) calls light verbs *general purpose verbs* in opposition *to specific action verbs* and notes that their use comes after children's even earlier use of also highly abstract particles such as *up, away*, and *off*. Clark suggests that children begin with these more general verbs and that they are replaced by more specific verbs, for example, *do* may be replaced by *build*, *cut*, *unwind*, and *go* by *run*, *drive*, *walk*. Similarly, Pinker (1989) suggests that the relational meanings of light verbs make them the core meanings of other heavier verbs to which other more specific meaning elements are added. According to Pinker, the relational structures of the light verbs reflect primitive and innate semantic elements. The implication would seem to be that light verbs are early precisely because they are light, general, and frequent. Pinker (1989), Ninio (1999a, 1999b), and Gleitman (1990) also suggest that light verbs promote the learning of argument structures. Ninio (see also Gilette et al., 1999; Goldberg, 1998) emphasizes the transparency of argument structure for light verbs and sees these verbs as *directly* encoding the meaning of the structure (SV, VO, or SVO). Thus, by learning these verbs, children learn an *abstract schema* that then facilitates the acquisition of many verbs that encode the same underlying causal and argument structure.

This view of light verbs as 'pathbreaking' has been challenged. First, several analyses of early verb use suggest that there is a transition from an early-restricted to a more widespread use of early verbs (Hart & Risley, 1995; Tomasello, 2003; Watkins, Rice, & Moltz, 1993). This suggests that early verbs might be narrower in their relational meaning than they are for adults. Second, recent cross-linguistic studies also suggest that in contrast to English, heavy verbs and not light verbs dominate early vocabularies: in Tzeltal (Brown, 1998a, 1998b), Tzotzil (De Leon, 1999), Korean and Chinese (Choi, 1998; Tardif, 1996). In her study of Tzeltal, Brown noted that Tzeltal-speaking children do not rely on semantically general verbs to a greater extent than adult speakers, which would be expected if these light verbs played a universal privileged role in the acquisition process (Brown, 1998a). Moreover, she proposes that heavy transitive verbs facilitate the learning of argument structure in Tzeltal-speaking children (Brown, 2008). These heavy Tzeltal verbs incorporate semantic features of the argument such as shape, substance, position, and orientation in ways that correspond to Tzeltal argument structure. In Brown's view, Tzeltal children's learning of argument structure is helped by starting from a concrete and strong link between an action and some very frequent object because the associated object provides clues to the relational meaning. Finally, Brown argues that the main difference between light and heavy transitive verbs in Tzeltal is that heavy verbs place restrictions on what their arguments can be, whereas light verbs are *semantically general* in the sense that they do not place so many restrictions on the objects that can fill the argument roles. In this context, Brown proposes an important role for heavy verbs: since Tzeltal is a language with massive argument ellipsis, if the object argument is dropped, the heavier verbs still carry information about the likely object, thereby reducing ambiguity.

There are several ways to understand the acquisition of English light verbs in the context of Brown's argument. One possibility is that early light verbs in English are not all that light, at least not for children. Further, some have suggested that light verbs in English are only learned early because they are so frequent (see De Villiers, 1984; Naigles & Hoff-Ginsberg, 1998; Theakston et al., 2004). Consistent with these ideas is growing evidence that all other things being equal verbs with more concrete meanings are learned more readily than ones with more abstract meanings (e.g., Bloom, 1991; Bloom, Lightblown, & Hood, 1975;

Gentner & Boroditsky, 2001; Hirsh-Pasek & Michnik Golinkoff, 2006; Huttenlocher, Smiley, & Charney, 1983; Shatz, Wellman, & Silber, 1983; Tardif & Wellman, 2000). A second possibility is that early light verbs in English do play a pathbreaking role, with their increasingly expanding use in more varied contexts (and with more varied argument structures) helping children to discover the relational meaning of verbs. If this is so, verb learning in other languages may be fundamentally different and use heavy verbs as the developmental pathbreakers (but see Lee & Naigles, 2005; Ma, Michnik Golinkoff, Hirsh-Pasek, McDonough, & Tardif, 2008; Sethuraman, 2004). A third possibility is that light and heavy verbs contribute differently to early verb learning, even in English. Heavy verbs in English, as Brown proposes for Tzeltal, may teach relational structure by constraining and pointing attention to object roles.

Answering these fundamental questions about verb learning requires a clear distinction between what verbs are ‘heavy’ and ‘light.’ At present there is no clear theoretical or empirical definition of ‘light’ and ‘heavy.’ Further, researchers often write about ‘light’ and ‘heavy’ as two distinct categories, when the more accurate description might be of a continuum from ‘lighter’ to ‘heavier.’ The goal of this study is to provide initial insight by examining one possible metric of the ‘lightness’ of a verb that might be useful – the number of different objects that are associated with the verb. The core idea builds on Brown’s proposal about the how heavy verbs might teach relational structure through constrained objects and object roles. If this is so, then one relevant and measurable aspect of ‘lightness’ might be the range of objects (and thus kinds of events) with which the verb is used. Accordingly, the study specifically examined the number of different objects associated with 80 early-learned transitive English verbs. Two different measures of association were used. In Study 1, adults were given each verb and asked to provide a single object that came to mind when they heard the verb. Such experimentally provided associations have been shown to be related to the statistical and semantic structure of a language (Deese, 1965; Gilhooly & Logie, 1980; Hills, Maouene, Riordan & Smith, in press; Steyvers & Tenenbaum, 2005). Study 2 attempted to measure the language learning environment more directly by measuring the co-occurrence of mentioned object names and mentioned verbs in a corpus of child-directed speech.

## Study 1

If light verbs are abstract in the sense that they are used to talk about many different specific events, then ‘light’ verbs should not be strongly associated with any one kind of object. In contrast, by hypothesis, heavy verbs span a narrower range of events, and thus they should be associated with a more limited set of objects. As a first test of this idea, we collected adult object associations, providing adults with each verb and then asking the adult to provide the object that comes to mind. This is a good first measure because past research shows that adult associations are highly revealing of the statistical properties of language and most critically the frequency of words and their co-occurrences (Deese, 1965; Gilhooly & Logie, 1980; Hills et al., in press; Steyvers & Tenenbaum, 2005). We examine the type-token distributions of object associations for 80 early-learned verbs, asking whether there are distinct categories of ‘light’ and ‘heavy’ verbs by this metric.

More specifically, the study measures the diversity of the objects associated with the 80 verbs. Figures 1a–1c illustrate three possible distributions showing the frequency of individual nouns associated with a verb as a function of the rank-ordered frequency with which the noun is offered as an associate for that verb. Figure 1a shows a hypothetical verb that is highly associated with a very small number of nouns, and thus the frequency with which a noun is offered as an associate falls rapidly as a function of the rank order of the frequency of the nouns associated with that verb. This is the pattern that might be expected

of a verb whose use is highly restricted to certain contexts and thus, by hypothesis, is 'heavy' (e.g., among adults a verb such as *slam-dunk* presents a clear case). Figure 1c shows a flat distribution; the nouns most frequently associated with the verb do not differ very much in their frequency. By hypothesis, this is the distribution pattern expected for verbs used in many different contexts and with many different objects, that is, for 'light' verbs. Figure 1b shows an intermediate pattern. The main question for Study 1 is what these distributions look like for early transitive verbs and whether they distinguish two classes of verbs, a potential class of light verbs and a potential class of heavy verbs.

## Method

**Participants—**The participants were 286 college undergraduates, whose first language was American English.

**Stimuli—**The verbs, given in Appendix 1, were 80 transitive verbs from the Bates–MacArthur Communicative Developmental Inventory for American English (MCDI, Fenson et al., 1994). This inventory (built from a normative study of over 1200 children) includes a list of 103 verbs that are normatively in the productive vocabulary of at least 50% of children learning American English by 30 months of age. In this list, the so-called helping verbs (*do*, *wanna*, *need*, *should*, *would*) are not present. We used the first entries in the Webster dictionary to categorize each verb in the list as transitive or intransitive.

**Procedure—**Participants were tested individually. Each was given a randomly ordered list of verbs on a computer screen, one verb at a time, and asked to supply (by typing the word on the keyboard) the *one object* that first came to mind given the verb. No constraints and no definition of what was meant by 'object' was provided. Thus, these free associations measure the strength of the connections in semantic memory between the verbs and the associates produced.

## Results

For the following analyses, singular and plural forms of the same noun (e.g., *keys* vs *key*) were considered to be the same type. Spelling errors were corrected ('dorr' for *door*) and shortened versions of words were grouped together with their full correspondents (*veggies* with *vegetables*, *phone* with *telephone*, *TV* with *television*). The few non-nouns (verbs, adjectives, or adverbs) provided by participants (12% of the offered associates, SD = 0.06) were excluded. Given this, there were 4509 unique object types in the 22,880 tokens.

To examine the distributions of associated objects for each verb we ordered the associated nouns by their frequency of occurrence as an associate for that verb. Figure 2 shows a sampling of the distributions for eight verbs. For each illustrated verb, the number of individuals offering each noun as an associate of the verb is given as a function of rank order of the noun types. As is apparent, the distributions of associated nouns differ considerably for different verbs. Some verbs, as in the case of *put* and *take* have many different associates, none of which are highly frequent. Some verbs, such as *knock* or *splash*, have only a few highly frequent associates (*door* for *knock*, *water* for *splash*). And some other verbs have an intermediate pattern, with many associates but some more frequent than the rest as in the case of *play*, *write*, or *wipe*. Thus, in this set of verbs there are distributions that are similar to all three of the hypothetical distributions shown in Figure 1.

For each of the 80 verbs, we calculated the following measures: the number of associated types, the frequency of the most frequently offered associate, and the sum frequency of the three most frequent associates. These are provided for each verb in Appendix 1 along with the age of acquisition (the age at which 50% of the children have the verb in productive

vocabulary according to the MCDI). Table 1 provides the means, ranges, and standard deviations of these measures of the distributions for the 80 verbs. There is considerable variation among these early verbs. The number of unique noun types offered by the 286 participants ranged from 25 to 141. For one verb, 250 of the 286 participants offered the same associate (*read – book*), whereas for other verbs, there were few agreements. The object associations offered for individual verbs were sensible; for example, 19 unique associations were offered for *splash*: water (206), pool (37), ocean (4), wave (3), waterfalls (3), paint (20), dolphin (2), beer (2), whale (1), pool water (1), mountain (1), lake (1), killer whale (1), flash (1), face (1), candy (1), boat (1), beach (1), and bath (1). The major constraining factor is semantic (kind of event) but not the type of construction as these objects could be potentially used with verb in subject, transitive, locative constructions. As shown in Table 2, and as is to be expected, the three measures of diversity – number of types, frequency of the most frequent type, and sum frequency of the three most frequent types – are strongly correlated with each other. All three measures are also significantly correlated, although weakly, with age of acquisition: number of types displays the strongest correlation of the three object metrics, $r(78) = .24$, $p < .05$.

Do these early-learned verbs fall into 'natural' groups of 'light' and 'heavy' by the diversity of associated objects? Such natural groups might be indicated by a bimodal distribution of the number of types, or of the frequency of the most frequent type. Accordingly, for each of the three graphs in Figure 3, the 80 verbs are ordered in the same way on the x axis, by number of unique types (thus, from 'heavier' to 'lighter') and the y axis shows, for this same ordering of verbs, (a) the number types, (b) the frequency of the most frequent type, (c) the sum frequency of the three most frequent types. Each distribution measure indicates a continuous distribution of verbs with no clear-cut clusters. There are verbs with a very narrow set of associated nouns and verbs with a very broad set and also many verbs at every point in between. In brief, there is no clear break between two categories of verbs by these measures.

However, the verbs that theorists of child language have designated as 'light' on other grounds do appear, for the most part, to have the broadest range of associated objects. We specifically examined the verb classifications offered by Clark (1978) and Pinker (1989), presented in Theakston et al. (2004), and these are listed in Appendix 1. For these 'light' verbs, Table 3 summarizes the noun associations provided by the participants in the present experiment in terms of the number of types, frequency of the most frequent associate, and sum frequency of the three most frequent associates and the table provides the same statistics for the contrasting verbs noted as 'non-light' by these authors.

This correspondence suggests that associated objects may be a relevant indicator. In particular, the verbs picked out as 'light' vs 'non-light' by these authors differ reliably and in the expected direction for total numbers of types of associated objects: $t(68) = -3.43$, $p < .001$, for the 'frequency of the most frequent' $t(68) = 6.43$, $p < .001$; and for the 'frequency of the three most frequent' associates $t(68) = 4.82$, respectively, $p < .001$. In brief, the noun associates of common verbs as provided by adults do appear to capture something about the difference between 'heavy' and 'light' verbs as discussed by previous investigators of children's verb learning.

All of the 80 verbs are relatively early learned and using the MCDI norms as the measure of age of acquisition, there is some evidence, albeit weak, as given in Table 2, that verbs with narrower object associations are, in general, acquired earlier. Past research (see especially Goodman, Dale, & Ping, 2008) suggests that many factors matter with regard to age of acquisition and generally one cannot predict the age of acquisition from any one factor. To explore how the diversity of object associations might relate to other factors relevant to age

of acquisition, we used frequency (Carroll & White, 1973) and imageability (Ma et al., 2008). The frequency of each verb was determined from the frequency in parental speech from the CHILDES corpora. Imageability ratings were taken from Cortese and Fugett (2004). For the diversity of associated objects, we used the number of associated types. A regression was conducted on the 72 verbs for which all three measures were available (see Table 4). Using the enter method, a significant model emerges, $F(3,68) = 3.38$, $p < .05$. But the model is weak, it accounts for only 9% of variance in the age of acquisition (adjusted $R^2$). Neither number of object types nor imageability were significant variables, but frequency was: $\beta = -.308$, $p <. 05$. The number of types was strongly and negatively correlated with imageability: $r(70) = -.65$, $p < .001$ but positively associated with frequency: $r(70) = .37$, $p = .01$) and age of acquisition: $r(70) = .26$, $p < .05$. In sum, if adult object associations are a relevant metric of lightness and heaviness, they do not suggest a clear acquisition advantage for one or the other.

## Study 2

Study 1 indicates that adults associate many early English verbs with a few prototypical objects and less strongly with a series of other objects. However, other early-learned verbs do not elicit a constrained set of prototypical object associations. Further, verbs populate the space between these two extremes of lightness and heaviness. We examined these associations because they seemed a plausible measure of the range of events with which these early verbs are used. We chose to examine co-occurrences in language use on four grounds. First, young children do readily provide associations. Second, comparisons of adult judgments with co-occurrence patterns in child corpus analyses have indicated correlated patterns (Kidd & Bavin, 2007). Third, co-occurrence patterns in corpora have been shown to be highly reliable indicators of syntactic categories but are, in and of themselves, objective and not dependent on a priori commitments about the properties of the words (Lund, Burgess, & Audet, 1996). Fourth, the co-occurrence patterns in the input themselves are part of the data from which children learn verbs and syntactic relations and so are interesting in their own right.

We specifically examined verb–noun co-occurrences in the CHILDES database (MacWhinney, 2000). There are three limitations to this approach. First, the number of tokens is small compared to the learning environment. Although there are nearly 1.5 million word tokens in the present corpus analysis, this number is still less than the 6 million word tokens heard by an average child in just one year (calculated from Hart & Risley, 1995). Second, the number of types is also small, as the range of everyday contexts of parent–child interactions sampled in this corpus is sufficiently constrained that even such common words as *basket* or *break* occur only a handful of times. Finally, because meaningful corpus analyses require a large number of instances to make sensible generalizations, we combined the utterance contexts. Even so, only 32 of the 80 target transitive verbs occurred at least 100 times in the CHILDES sample. The following analyses consider only these 32 verbs.

### Procedure

All of the corpora, a total of 36, in the American English portion of the database (MacWhinney, 2000) available at the time of analysis (October 2005) were used. In all, there were 2163 transcripts comprising 1,481,858 transcribed utterances. Activities included: structured and unstructured conversation with parents, relatives, friends, neighbors, acquaintances, experimenters, and other strangers; greeting, gift-giving, and leave-taking; structured and unstructured play with and without manufactured toys; preparing, eating, and cleaning up after snacks and meals; story reading; preparing for and waking up from naps and nightly sleep; preparing for, arriving at, participating in, and returning home from school or daycare; transit (e.g., between home and school by foot,

automobile, bus, or subway); and other everyday activities and experimental tasks. Locations included homes, schools, laboratories, and other venues in both rural and urban settings across the USA. Participants ranged in SES from working class to upper-middle class and were primarily of Caucasian American or African American ethnicity. Speech to and by 899 children and their parents was analyzed; the children in these conversations ranged in age from 6 months through 10 years, although the majority of children were between 1 and 5 years.

The co-occurrence counting procedures used a computer program written in Python using the SciPy libraries (Jones, Oliphant, & Peterson, 2001). For each transcript, the program first identified the 'target child' (the child to whom parental utterances were directed). In transcripts with only one child, it was assumed that child was the target child. In transcripts where more than one child was represented, the script used the CHAT participant ID header to identify the target child. Next, the program identified parents in the transcript, using the roles 'Mother' and 'Father' in the CHAT participant ID header. Transcripts for which a parent could not be identified were excluded. Next, the program went through each utterance in the transcript. Utterances not produced by the target child or parent were ignored. (This conservative approach to participants excluded experimenter interventions and non-child-directed language, which are sometimes a part of these transcripts.) For each utterance included in the analysis (parent speech and target child speech), the program examined the morphosyntactic coding to identify nouns (pronouns were excluded) and the 80 transitive verbs from Study 1. All forms of a verb (*splash, splashed, splashing*) were considered to be the same verb. For each verb, the program extracted the first noun after the verb. These nouns are not necessarily, though they may be, the grammatical object of the verb that precedes them. There was a significant positive correlation, $r(533) = .76$, $p < .001$, between the token frequencies of words extracted by the method used here and the token frequencies of the 535 matching syntactic objects in a random sample of 59,977 utterances from 123 CHILDES transcripts that had previously been hand-tagged for grammatical role (Laakso & Smith, 2007). In any case, whether or not the nouns function as syntactic objects, they likely refer to objects salient in the ongoing events referred to by the preceding verb.

## Results

These analyses considered only the 32 verbs that occurred more than 100 times in parent and child speech (combined) and the first noun that followed these verbs (as in Study 1, variants of the same noun and plural forms, were counted as the same type). Because the number of occurrences of these verbs in the dataset varied, measures of the distribution of associated nouns – diversity of types, frequency of the most frequent, frequency of the three most frequent – were calculated in terms of the proportion of the total number of occurrences. These are provided for each of the 32 verbs in Appendix 2.

Table 5 provides the means, ranges, and standard deviations of these measures of the distributions of verb–next noun co-occurrences for the 32 verbs from the CHILDES database and for the object associations for these same 32 verbs from the adult associations of Study 1 (Table 2). Again there is considerable variation among the verbs, with some occurring with many different nouns and others occurring 100% of the time (*read*) with just one or with just a few nouns. Overall, however, noun associations in the input appear much more constrained than the adult-generated object associations for these same 32 verbs. The type-token ratio is lower in the CHILDES co-occurrence data than in the adult associations, $t(31) = 7.84$, $p < .001$; the proportional frequency of the most frequent type is greater in the CHILDES data than the adult associations, $t(31) = -5.520$, $p < .001$; and the three most frequent co-occurring nouns in the CHILDES dataset account for proportionally more of the occurrences than do the three most frequent associations in the adult data. Indeed, the

overall lack of diversity in CHILDES co-occurrences is considerable: on average, the most frequent noun accounts for 60% of all co-occurring nouns (SD = 0.20) and the three most frequent, on average, account for 86% of all co-occurring nouns (SD = 0.13). If the CHILDES data accurately reflect language in children's environment, verbs do not occur in diverse contexts but instead occur in more limited contexts and thus with a few specific nouns. Although the CHILDES data are more limited than the full range of children's experiences, they do include (as listed in the methods) a variety of situations. Nonetheless, the specific nouns that co-occur with specific verbs are limited, and seem to be generally so for all verbs.

Figures 4a, 4b, and 4c show the type-token ratio, the proportion of tokens that were the most frequent type, and the proportion of tokens that were the three most frequent types for these 32 verbs in the CHILDES co-occurrence data and in the adult association data for the same verbs. As can be seen, across this set of 32 verbs, there are many that would be deemed 'light' by the breadth of adult noun associations, yet would appear quite 'heavy' in the sense of co-occurrence with a narrow set of nouns in the CHILDES corpus. The perfect example here is *push*. The distribution of the noun associations by adults is quite broad. However, in the CHILDES corpus, *push* is mostly about *pushing buttons*, accounting for 83% of the occurrences. These differences between the 'heaviness' of verbs by object co-occurrences in the CHILDES data vs their 'lightness' as measured by adult associations may reflect a fundamental fact about how verbs are more constrained in language to and by children, an idea we consider more fully in the general discussion.

One cautionary note with respect to this idea is the present analyses only considered co-occurring nouns (e.g., *pushing buttons*) and not instances in which the verb occurred with pronominal forms (e.g., *push it/that*). We focused on nouns because they provide an index of the diversity of the event contexts in which the verbs were used, whereas pronouns provide no such information. However, it is possible that 'light' verbs occur more in contexts in which the specific objects are not labeled at all (see Laakso & Smith, 2007). Finally, it is also possible that the differences between Study 1 and Study 2 reflect the differences in the two measures and not age-related differences in the diversity of object contexts in which light verbs occur. We note, however, that other comparisons of adult judgments and child corpus analyses suggest correlated patterns (Kidd & Bavin, 2007).

Because only 30 verbs out of these 32 verbs have imageability ratings in Cortese and Fugett (2004), we used only these 30 verbs to examine relations between frequency, noun associations, and imageability (Table 6). Frequency of types is correlated with age of acquisition, $r(28) = .35$, $p < .05$. There is also a negative correlation between imageability and frequency, $r(28) = -.72$, $p < .01$. Of course, frequency and co-occurrences in the CHILDES corpus, age of acquisition as measured by the MCDI norms, and imageability from adult ratings are all 'global' measures of these verbs and are not fine-grained measures about what individual children hear or know, or about individual ages of acquisition. Nonetheless, the overall pattern suggests that the distributions of co-occurring objects may provide a useful measure of concreteness (or heaviness) and of the diversity of contexts thus abstractness of verb meanings.

## General discussion

Jesperson (1965) is generally credited with coining the term 'light verb' in his analysis of English V+NP constructions. Although the term has been criticized (e.g., Butt, 2003) because of the lack of general agreement on just what constitutes a 'light' verb, many authors have suggested that 'light' verbs may play special role in early verb learning (Clark, 1978; Gilette et al., 1999; Goldberg, 1998; Ninio, 1999a, 1999b; Pinker, 1989; Theakston et

al., 2004). In the context of current understanding, the present results on object associations and noun–verb co-occurrences for early-learned transitive verbs make three contributions. First, the findings affirm the distinction in the sense of indicating that verbs differ considerably in the number of objects with which they are associated in adult judgments. However, by the measure of object associations the difference among verbs may be better understood as a continuum from 'heavier' to 'lighter' verbs. Second, the results also suggest that object associations from the adult may not correctly reflect the diversity of contexts for these verbs in the learning environment for children. As such they may also not reflect children's understanding of the range of objects useable with these verbs. Third, these results and verb–object associations we have collected provide new directions for pursuing the fundamental question of whether different kinds of verbs are learned in different ways and perhaps also provide early learners with different lessons, and different boot-straps, into verb learning.

## A continuum of object associations

Adult associations are a well-accepted index of semantic relatedness that has proven robust in predicting adult semantic judgments in a variety of tasks (e.g., Nelson, McEvoy, & Schreiber, 1998). In summarizing a large body of work, Deese (1965) concluded that these associations reflect the contiguity, semantic, and frequency properties of words in the language. The present findings that these associations pick out the same verbs that theorists of child language have discussed as 'light' and 'heavy,' that they are correlated with imageability measures of verbs (another possible index of concreteness), and that these associations correlate with age of acquisition support the use of object associations as a potentially relevant measure of the differences among verbs. We suggest that associations might be usefully taken at face value, as indicating the breadth or narrowness of the range of objects in the events to which these verbs refer. Considered in this way, the present results tell us that although many early-learned verbs are 'light' (from the adult perspective), some are also 'heavy' and there is the full range in between. Thus, we must be wary of over-generalizations that 'light' verbs are learned early or serve a special 'pathbreaking' role.

Clearly, there is a need for converging evidence on the implications of these associations for acquisition. However, these associations, and the continuum of verbs, open new questions and new methodological approaches. For example, it would be interesting to know the relation between this nearly linear distribution of verbs by adult object associations and argument dropping in English. Some English verbs can take an implicit object in English (Nicol, Resnik, & Landau, 2003; Nicol Medina, 2007). For example, the verb *eat* can either omit or preserve its external argument in the surface syntax (*I eat lunch/I ate*), but a verb such as *want* must specify its external argument (*I want a prize/* I want*). As Brown (2008) suggested in her analysis of early Tzeltal verbs, heavier verbs may allow for implicit objects because the verb itself is narrowly associated with a small set of nouns making misunderstanding unlikely. Consistent with this idea, Resnik (1996) demonstrated that verb selectivity correlates with object omissions in adult speech. Thus, one useful next step in validating adult object associations as an index of relative 'lightness' would be to examine the relation between the narrowness of these associations and argument omission. Also, relevant to this idea would be an examination of the use of pronouns and pronoun diversity. Another measure that could be used to validate both associations as a metric on lightness and also the psychological importance of a continuous distribution of verbs with respect to their object associations would be priming studies examining whether and how associated objects might prime lexical decisions about verbs. Developmentally, one might want to ask whether children comprehend the meaning of verbs with fewer object associations more narrowly, as more specific to specific kinds of relations, but comprehend verbs associated with more diverse objects in terms of more abstract and generalizable relations. That is, by

using the ordering of verbs by the diversity of object associates (as provided in Appendix 1), we may gain a deeper understanding of whether the developmental pattern differs for heavier and lighter verbs. Such studies examining a range of verbs (and not just verbs from the 'light' and 'heavy' extremes) are critical if we are to understand whether 'light' and 'heavy' constitute a useful distinction with respect to verb learning and comprehension.

## Do some verbs start 'heavier' for young learners of English?

The adult association data and the noun–verb co-occurrence data from the CHILDES corpus differ considerably. The adult association data indicate significant differences in the range of nouns associated with the verbs whereas the CHILDES co-occurrence data suggest a narrow range of co-occurring nouns for a subset of examined verbs and overall a much narrower range of co-occurring nouns in this corpus than associated nouns from adult judgments. These differences, could, of course, reflect the differences in the methods rather than telling us something about differences between adult verb semantics and children's learning environment. In general, adult associations are strongly correlated with co-occurrences in adult corpora (e.g., Lund et al., 1996; Spence & Owens, 1990) and comparisons of adult judgments and co-occurrence patterns in child corpus analyses yield correlated patterns (Kidd & Bavin, 2007). Nonetheless, the limited number of objects co-occurring with the verbs in the CHILDES corpus raises the intriguing possibility that at least some early verb learning begins with a tight link to a few specific events (and thus kinds of objects) and moves toward adult lightness in the course of mastering the verbs.

The study of child language development has made clear the tension between consistency and diversity in the input as children break into language and move toward mature productivity (Goldberg, Casenhiser, & Sethuraman, 2004; Naigles & Hoff-Ginsberg, 1995, 1998; Tomasello, 2003). Highly consistent patterns seem helpful in allowing children to discover and latch onto a to-be-learned regularity. Diversity, in contrast, would seem essential to children's abstraction of the underlying relations and rules and to the productive use of those patterns. In the context of verb learning, there have been a number of suggestions that a narrow range of inputs (high consistency) particularly with respect to argument structure may aid in verb learning (Goldberg et al., 2004) and that with development there is increasing diversity in the input. The present results raise the possibility that this may be true for the contexts and specific nouns that co-occur with specific verbs. These could be beneficial for learning relational structure by establishing well-grounded contextual islands from which the child could branch out (Tomasello, 2003). Further, there is plenty of evidence for the claim that diversity of input predicts diversity of child language (Hart & Risley, 1995; Watkins et al., 1993).

These conjectures raise several further questions about the relations between the adult association data and the CHILDES co-occurrence data. Both the adult association data and the CHILDES co-occurrence data predict age of acquisition for these verbs (albeit weakly). Children do not, of course, have direct access to adult word associations. Instead, these associations must stand in a predictive relation to acquisition because they themselves are products and indices of the regularities in the learning environment. Given that the diversity of adult associations does predict age of acquisition as do the CHILDES co-occurrences, it will be important in future work to systematically examine the possible relations between adult associations and CHILDES co-occurrences (see for a first attempt, Hills et al., in press).

## Object associations as indices of 'lightness' and 'heaviness'

We see three main contributions in this work: (1) the set of object associations to 80 early-learned transitive verbs, (2) the finding that early-learned verbs differ widely on this

measure, and (3) the finding that there is no sharp division between classes of verbs by this measure. We propose that these data provide a first step – and a pathway – to understanding how children break into verb learning and to understanding whether different kinds of verbs are learned in different ways or provide different early lessons about verb semantics. These object associations can be used[1] to ask systematic questions about the role of objects in constraining early acquisition. For example, these associations might be used to ask whether very young children first comprehend verbs in limited object contexts, whether they generalize verbs with narrower vs broader object associations differently, and whether the objects associated with these verbs (and/or the objects that co-occur with verbs in the child-directed speech) are perhaps deeply related to the relational meanings of those verbs in ways that might promote learning that relational structure. If many or even just some early verbs are learned in tightly constrained contexts with limited kinds of objects, then as Brown (2008) suggested for early Tzeltal verbs, those 'heavier' verbs and more constrained contexts could play a key role in children's discovery of the underlying relational structure.

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[1]The full set of associations is available at http://www.gvsu.edu/psychology/josita-maouene-159.htm.

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## Appendix 1

The distributions of the three measures of the object associations for the 80 transitive verbs: Types – the number of unique associated objects; Most frequent – the number of associated objects accounted for by the single most frequent associated object; and Three most frequent – the sum of associated objects accounted for by the three most frequently associated objects. Also given is 'age of acquisition' (AoA) – which is the age (in months) at which 50% of children are reported to have the verb in their productive vocabulary in normative studies (Fenson et al., 1994) and a summary of the designations of these verbs as 'light' and 'heavy' (or 'non-light') by others as given in Theakston et al. (2004)

| Verbs | Number of types | Most frequent | Three most frequent | AoA MCDI norms | Pinker & Clark |
|---|---|---|---|---|---|
| bite | 25 | 66 | 136 | 21 | heavy |

| Verbs | Number of types | Most frequent | Three most frequent | AoA MCDI norms | Pinker & Clark |
|---|---|---|---|---|---|
| blow | 58 | 29 | 75 | 23 | heavy |
| break | 81 | 90 | 112 | 23 | heavy |
| bring | 90 | 42 | 65 | 25 | light |
| build | 48 | 129 | 180 | 27 | heavy |
| bump | 72 | 49 | 103 | 27 | n/a |
| buy | 53 | 57 | 120 | 23 | heavy |
| carry | 64 | 50 | 96 | 24 | heavy |
| catch | 30 | 154 | 188 | 30 | heavy |
| chase | 73 | 54 | 106 | 23 | heavy |
| clap | 31 | 221 | 228 | 23 | heavy |
| clean | 70 | 55 | 119 | 23 | heavy |
| climb | 19 | 96 | 209 | 25 | heavy |
| close | 40 | 166 | 179 | 25 | n/a |
| cook | 53 | 127 | 155 | 23 | heavy |
| cover | 62 | 71 | 115 | 28 | heavy |
| cut | 47 | 48 | 119 | 26 | heavy |
| draw | 43 | 95 | 168 | 25 | heavy |
| drink | 32 | 91 | 162 | 21 | heavy |
| drive | 22 | 215 | 227 | 23 | heavy |
| drop | 76 | 56 | 89 | 26 | heavy |
| dry | 65 | 46 | 101 | 27 | heavy |
| dump | 44 | 77 | 164 | 30 | n/a |
| eat | 41 | 186 | 204 | 19 | heavy |
| feed | 51 | 46 | 103 | 26 | heavy |
| find | 97 | 29 | 65 | 25 | heavy |
| finish | 44 | 71 | 157 | 29 | heavy |
| fix | 70 | 57 | 121 | 23 | heavy |
| get | 75 | 30 | 62 | 23 | light |
| give | 53 | 48 | 129 | 22 | light |
| hate | 129 | 25 | 49 | 30 | n/a |
| have | 95 | 56 | 79 | 26 | heavy |
| hear | 47 | 132 | 170 | 26 | heavy |
| help | 85 | 29 | 62 | 23 | heavy |
| hide | 77 | 29 | 68 | 25 | heavy |
| hit | 44 | 102 | 161 | 23 | heavy |
| hold | 74 | 83 | 112 | 23 | heavy |
| hug | 44 | 40 | 95 | 21 | n/a |
| kick | 24 | 149 | 179 | 23 | heavy |
| kiss | 39 | 99 | 154 | 21 | heavy |
| knock | 20 | 224 | 243 | 25 | heavy |
| lick | 53 | 82 | 136 | 27 | heavy |
| like | 89 | 30 | 69 | 25 | heavy |

| Verbs | Number of types | Most frequent | Three most frequent | AoA MCDI norms | Pinker & Clark |
|---|---|---|---|---|---|
| love | 75 | 84 | 107 | 23 | n/a |
| make | 87 | 37 | 83 | 26 | light |
| open | 36 | 168 | 198 | 22 | heavy |
| paint | 48 | 68 | 149 | 26 | heavy |
| pick | 95 | 59 | 97 | 29 | heavy |
| play | 64 | 64 | 111 | 23 | heavy |
| pour | 43 | 76 | 123 | 27 | heavy |
| pretend | 100 | 12 | 34 | 30 | heavy |
| pull | 54 | 86 | 134 | 26 | heavy |
| push | 79 | 52 | 79 | 24 | light |
| put | 92 | 23 | 52 | 25 | heavy |
| read | 18 | 246 | 250 | 22 | heavy |
| ride | 26 | 96 | 220 | 22 | heavy |
| rip | 57 | 63 | 118 | 30 | heavy |
| say | 48 | 81 | 149 | 27 | heavy |
| see | 72 | 104 | 137 | 21 | heavy |
| shake | 65 | 76 | 135 | 29 | n/a |
| share | 80 | 61 | 115 | 27 | heavy |
| show | 95 | 54 | 92 | 27 | heavy |
| sing | 27 | 103 | 145 | 25 | heavy |
| spill | 41 | 64 | 160 | 26 | heavy |
| splash | 19 | 206 | 247 | 26 | heavy |
| stop | 19 | 127 | 173 | 24 | heavy |
| sweep | 27 | 135 | 221 | 27 | heavy |
| swing | 26 | 78 | 150 | 22 | n/a |
| take | 141 | 31 | 62 | 27 | light |
| taste | 46 | 96 | 171 | 29 | heavy |
| tear | 44 | 57 | 72 | 30 | heavy |
| think | 51 | 90 | 120 | 30 | heavy |
| throw | 32 | 187 | 217 | 23 | heavy |
| tickle | 60 | 27 | 64 | 22 | heavy |
| touch | 74 | 52 | 114 | 26 | heavy |
| wash | 38 | 75 | 176 | 22 | heavy |
| watch | 41 | 86 | 142 | 25 | heavy |
| wipe | 58 | 26 | 62 | 25 | heavy |
| wish | 53 | 111 | 146 | 30 | n/a |
| write | 29 | 102 | 172 | 27 | heavy |

## Appendix 2

The 32 verbs with over 100 occurrences in CHILDES and their frequency of occurrence in CHILDES and three measures of the diversity of the first noun that follows the verb in terms of the proportion of occurrences of the verb: Types – the proportion of unique co-occurring nouns; Most frequent – the proportion of occurrences accounted for by single most frequent

co-occurring noun; and Three most frequent – the proportion of occurrences accounted for by the three most frequent co-occurring nouns.

| Verbs | Occurrences in CHILDES | Types | Most frequent | Three most frequent |
|---|---|---|---|---|
| blow | 125.00 | 0.04 | 0.72 | 0.88 |
| bring | 118.00 | 0.10 | 0.47 | 0.74 |
| build | 129.00 | 0.09 | 0.43 | 0.86 |
| catch | 119.00 | 0.10 | 0.50 | 0.82 |
| close | 258.00 | 0.01 | 0.65 | 1.00 |
| draw | 245.00 | 0.06 | 0.83 | 0.93 |
| drink | 140.00 | 0.05 | 0.69 | 0.95 |
| eat | 279.00 | 0.03 | 0.41 | 0.82 |
| find | 102.00 | 0.21 | 0.15 | 0.46 |
| get | 348.00 | 0.03 | 0.62 | 0.91 |
| give | 200.00 | 0.06 | 0.57 | 0.85 |
| have | 443.00 | 0.03 | 0.51 | 0.84 |
| hear | 130.00 | 0.12 | 0.42 | 0.76 |
| hit | 115.00 | 0.08 | 0.49 | 0.89 |
| hold | 116.00 | 0.05 | 0.81 | 0.97 |
| like | 200.00 | 0.07 | 0.50 | 0.76 |
| make | 375.00 | 0.03 | 0.46 | 0.74 |
| open | 315.00 | 0.01 | 1.00 | 1.00 |
| play | 376.00 | 0.01 | 0.66 | 0.97 |
| push | 133.00 | 0.05 | 0.83 | 0.98 |
| put | 560.00 | 0.02 | 0.53 | 0.87 |
| read | 691.00 | 0.00 | 0.91 | 1.00 |
| ride | 184.00 | 0.05 | 0.70 | 0.88 |
| see | 336.00 | 0.04 | 0.42 | 0.74 |
| show | 148.00 | 0.10 | 0.32 | 0.58 |
| sing | 214.00 | 0.03 | 0.96 | 0.98 |
| take | 303.00 | 0.02 | 0.65 | 0.96 |
| think | 121.00 | 0.14 | 0.30 | 0.61 |
| throw | 222.00 | 0.11 | 0.64 | 0.81 |
| wash | 240.00 | 0.02 | 0.86 | 0.98 |
| watch | 140.00 | 0.07 | 0.61 | 0.92 |
| write | 189.00 | 0.03 | 0.64 | 0.97 |

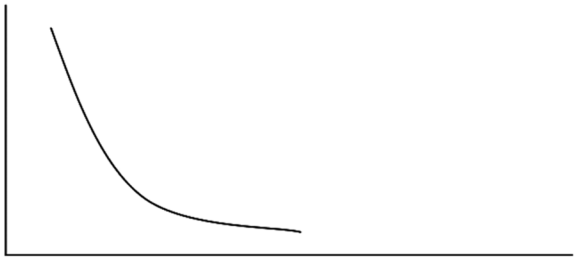

Figure 1a

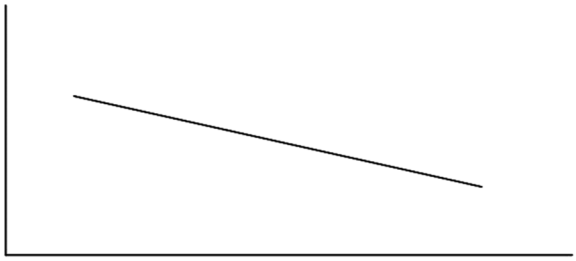

Figure 1b

Figure 1c

**Figure 1.**

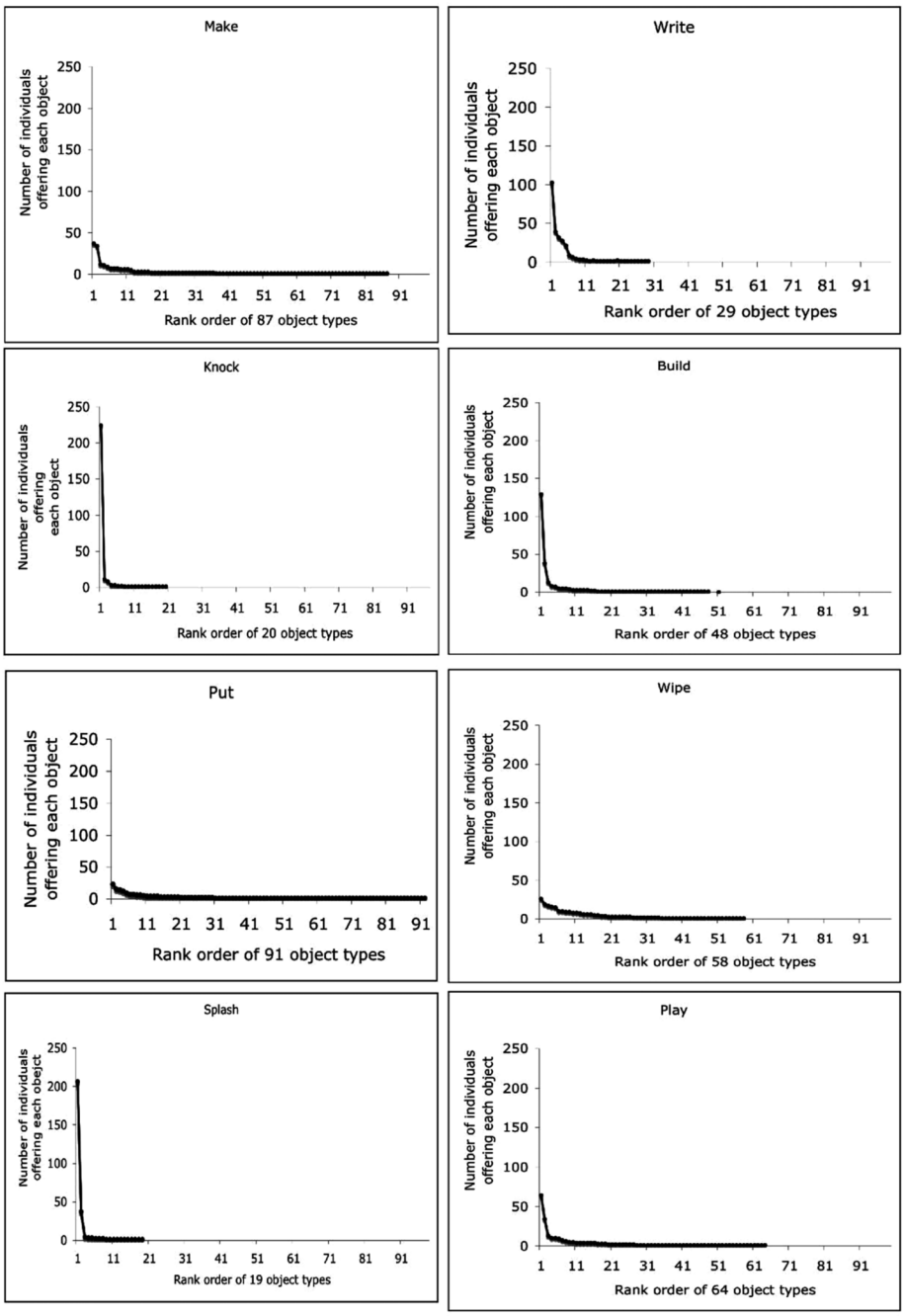


**Figure 2.**

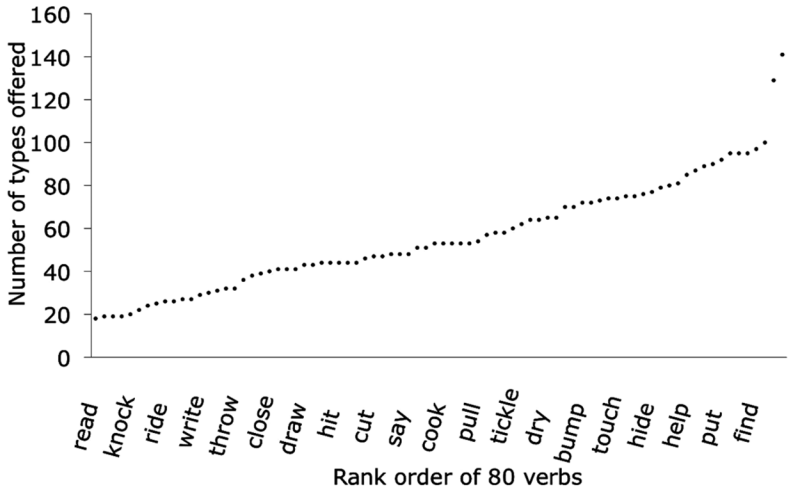


**Figure 3a**

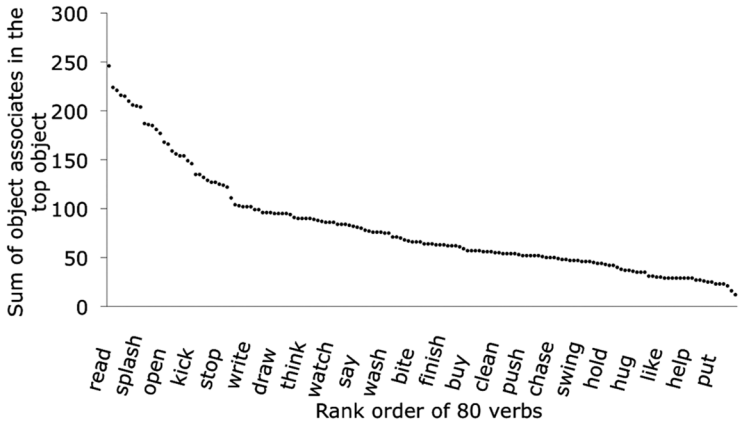


**Figure 3b**

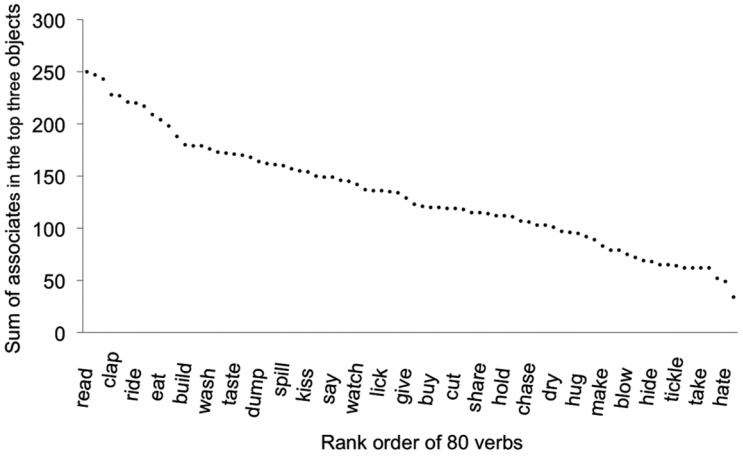


**Figure 3c**

**Figure 3.**

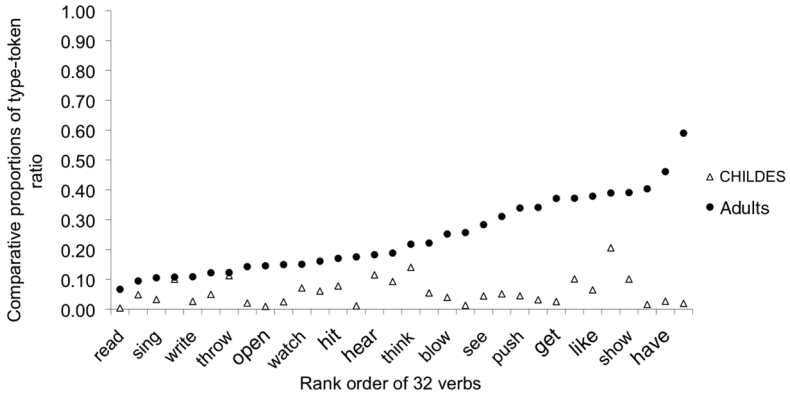


**Figure 4a**

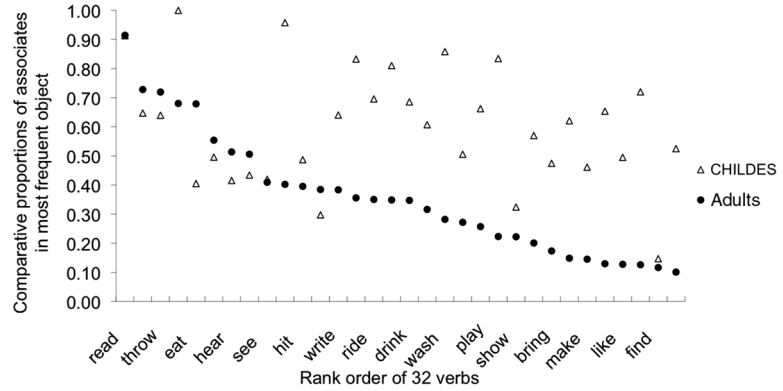


**Figure 4b**

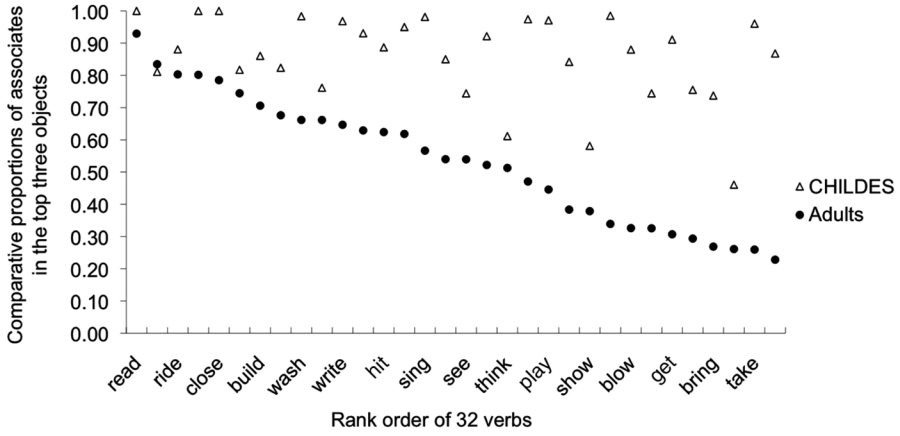


**Figure 4c**

**Figure 4.**

**Table 1**

Means, ranges, and standard deviations of the 80 verb distributions for the three object association measures and age of acquisition (AoA)

| | Number of types | Frequency 1st | Frequency 1–3 | AoA |
|---|---|---|---|---|
| Mean | 87.24 | 77.5 | 125.6 | 25.0 |
| Range | 37–162 | 21–216 | 54–248 | 19–30 |
| SD | 28.2 | 49.2 | 49.7 | 2.7 |

## Table 2

Correlation matrix on 80 verbs for all object association measures and age of acquisition (AoA)

| | Number of types | Frequency top object | Sum frequency top 3 objects | AoA CHILDES |
|---|---|---|---|---|
| Types | 1.00 | | | |
| Freq. 1st | −.67** | 1.00 | | |
| Freq. 1–3 | −.82** | .92** | 1.00 | |
| AoA | .24* | −.20* | −.19* | 1.00 |

** Significant at $p < .01$ level, one-tailed;

* significant at $p < .05$ level, one-tailed.

**Table 3**

Summary table of the means for all object association measures for Clark's and Pinker's classification of 72 verbs as light or heavy

| | Mean types | Mean top object | Mean top 3 objects | Mean AoA |
|---|---|---|---|---|
| Light | 87.5 | 40.00 | 80.00 | 24.5 |
| SD | 29.3 | 8.96 | 25.63 | 1.87 |
| Heavy | 53.33 | 90.38 | 139.4 | 24.9 |
| SD | 22.95 | 54.92 | 52.69 | 2.54 |

**Table 4**

Correlation matrix of 72 verbs for all object association measures and imageability (Cortese & Fugett, 2004), frequency in CHILDES and age of acquisition (AoA) (Fenson et al., 1994)

| | Frequency in CHILDES | Type-token ratio | Imageability ratings | AoA MCDI | Top object | Top 3 objects |
|---|---|---|---|---|---|---|
| Frequency in CHILDES | 1.00 | | | | | |
| Types | .37** | 1.00 | | | | |
| Imageability | −.61*** | −.65*** | 1.00 | | | |
| AoA | −.07 | .26* | −.22* | 1.00 | | |
| Top object | −.2 | −.66*** | .37* | −.2 | 1.00 | |
| Top 3 | −.32** | −.81*** | .5 | −.19 | .88*** | 1.00 |

*** Significant (one-tailed) at $p < .0001$ level;

** significant (one-tailed) at $p < .001$ level;

* significant (one-tailed) at $p < .05$.

**Table 5**

Means, ranges, and standard deviations of the 32 verb distributions for the three object association measures and age of acquisition (AoA)

| | Number of occurrences | Number of types | Freq. 1st | Freq. 1–3 | AoA |
|---|---|---|---|---|---|
| Mean | 237.93 | 10.03 | 149.88 | 209.16 | 24.34 |
| Range | 115–691 | 3–25 | 36–631 | 47–691 | 19–30 |
| SD | 138.79 | 5.24 | 116.24 | 135.14 | 2.49 |

**Table 6**

Correlation matrix of 30 verb–object association measures and imageability (Cortese & Fugett, 2004), frequency of parental input to children in CHILDES, and age of acquisition (AoA) (Fenson et al., 1994)

| | Types | Top object | Top 3 object | Freq. parental input CHILDES | Imageability | AoA |
|---|---|---|---|---|---|---|
| Types | 1.00 | | | | | |
| Top | −.69** | 1.00 | | | | |
| Top 3 | .14 | .14 | 1.00 | | | |
| Freq. parental | −.17 | −.17 | .05 | 1.00 | | |
| input CHILDES Imageability | −.14 | .37* | .05 | −.72** | 1.00 | |
| AoA | .35* | −.28 | .14 | .05 | −.26 | 1.00 |

** Significant at $p < .01$ level (one-tailed);

* significant at $p < .05$ (one-tailed).

*First Lang*. Author manuscript; available in PMC 2013 December 19.