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THE BODY REGION CORRELATES OF CONCRETE AND ABSTRACT VERBS IN EARLY CHILD LANGUAGE

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ABSTRACT

Literature on verb acquisition has mainly focused on lightness and concreteness for verb acquisition whereas the analysis presented here points to an embodied perspective on word learning, examining whether early-learned verbs are associated with distinct parts of the body, and whether early-learned verbs might be more or less associated with parts of the body depending on whether they are abstract or concrete. Three dimensions of abstractness-concreteness were considered: semantic lightness, imageability, and number of associated objects. These factors were also examined in light of the age of acquisition and frequency of the verbs. This study presents evidence that embodiment is an important factor to consider in children's acquisition of verbs, with two major findings: 1) those verbs that are more highly associated with a single region of the body, according to adult judgments, are among the first acquired in vocabulary development; 2) associations with a specific region of the body may be a better predictor of whether a verb is learned early than the concreteness or abstractness of the verb. Taken together, these results suggest that we should further investigate the role of bodily experiences in verb meaning acquisition.

KEYWORDS: *body regions, verbs, concrete, abstract, corpus study*

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INTRODUCTION

Recently, embodiment, the notion that the body and its morphology are partners in higher cognitive processes, has been examined in the study of verbs, both in adult usage and in children's acquisition. The importance of body parts in learning and processing verbs has been shown by Maouene, Hidaka & Smith (2008), who find that adults systematically and coherently associate 100 early-learned verbs (Fenson, Dale, Reznick, Bates, Thal, & Pethick, 1994), a list that includes both abstract and concrete verbs, with five body regions: eye, ear, mouth, leg and hand. In the current study, we follow up on these results by asking whether body regions are more strongly associated with abstract verbs or concrete verbs.

The organization of the introduction is as follows. First, we review the literature supporting the idea that body parts are important in verb learning and processing. Second, in two sections, we review the literature arguing that 1) abstract cues and 2) concrete cues are important for learning and understanding verbs. Finally, we return to the specific questions of the current study, which asks whether body parts are equally important for both abstract and concrete verbs by examining abstractness-concreteness using three definitions: light versus non-light; high imageability vs. low imageability; and associated with many object types vs. associated with few object types.

Body parts in verb learning

Body parts have very interesting concrete and abstract characteristics in the two types of environments that matter for language acquisition, the observable world and the linguistic world. In the observed socio-cultural and spatio-temporal world of events, body parts transport us, create art, manipulate tools, possess objects of different sizes, feed us, sense danger, and connect us to others. In many ways, body parts are "causal" and are central to the "intentionality" of many events. In the linguistic world, body parts are represented by nouns and are explicit or implicit semantic components of verbs' relational meanings (Bowerman, 2005; Bowerman & Brown, 2008). As nouns, body parts can play many syntactic roles, not only subjects and direct or indirect objects but also obliques (such as instrumental and locative). Even as nouns, the number of terms referring to body parts is quite restricted, particularly in young children, making them close to a closed class of words. The presence of body parts is covert in proper nouns (*Tom, Sheila*), in labels for humans (*girl, boy*), and in animals, all categories that are very interesting to young children. Finally, body part terms are also apparent in prepositions (*back, front*) and in objects (*the leg of the table, the bottom of the page*).

We suspect that the importance of body parts might be scaffolded by the fact that children initially begin learning through a physically engaged body (Piaget, 1953; Thelen & Smith, 1994), from the child's own perspective (Huttenlocher, et al., 1983), and because developmentally, intelligence resides to a large extent in our own sensory-motor system (Piaget, 1953). Body parts may also be an important early bootstrap for general learning due to many factors, including that (a) for a child, her body is a constant frame of reference (Varela, Thompson & Rosch, 1983), long before productive language kicks in (Tincoff & Jusczyk, 2011); (b) body parts include parts and whole (see for example the importance of part-whole structure in ontologies and perception) and include a ubiquitous spatial organizing principle (de Leon, 1994); and (c) the child's body is excellent at capturing regularities or patterns, such as auditory patterns in newborns (Gervain, Macagno, Cogoi, Peña, and Mehler, 2008) and infants (Saffran, Aslin, & Newport, 1996) and eye-movement patterns in infants (Smith & Yu, 2010). It would therefore seem very plausible that, early on, the regular way regions of the body get used in activities would contribute to the scaffold of early understanding and use of relational meaning, both abstract and concrete.

Recently, embodiment, the idea that the body may shape knowledge because it stands between the world and the mind (for reviews on embodiment, see, for example, Barsalou, 2008; Glenberg, 2010; Wilson, 2002; Ziemke, 2001; and for its mechanistic challenges, see Pezzulo, Barsalou, Cangelosi, Fischer, McRae & Spivey, 2011), has attracted interest in the study of verbs. In adults, event-related potential studies and fMRI studies have shown that reading a verb (e.g., *kick*) activates the cortical motor areas relevant to moving the appropriate body part (e.g., leg and foot) (Hauk, Johnsrude, & Pulvermüller, 2004; Pulvermüller, Lutzenberger, & Preissl, 1999; also see Boulenger, Roy, Paulignan, Deprez, Jeannerod, & Nazir, 2006). Behavioral studies also suggest a connection between verb processing and movements made by particular parts of the body. For example, moving the arm away from the body slows judgment about the sentence "Open the drawer", an action involving the movement of the arm toward the body (Glenberg & Kaschak, 2002). Such results support the idea that the processing of verb meanings may involve or interact with some of the same processes that generate bodily action (Barsalou, 1999, 2003).

In children, James & Maouene (2009) find that merely hearing verbs but not hearing neutral adjectives significantly recruits regions of the premotor and primary motor cortices in four-to-six-year-olds. The results also suggest that the activation might be effector-specific: that is, verbs associated with hand movements activate different regions of the frontal cortex than verbs associated with leg movements, although some overlap is also possible. Further, James and Swain (2011) have shown that, in children, hearing novel verbs used while *actively* exploring objects but not while *passively* watching exploration of objects creates sensory-motor systems in the developing brain. Similarly, in a behavioral study, young children were shown to comprehend individual verbs in the context of their own actions but not in the context of the actions of others (Huttenlocher, Smiley, &

Chaney, 1983; see also Piaget, 1953; but, see Rizolatti and Craighero, 2004; Childers & Tomasello, 2006). These results argue for an early connection between verbs and motor regions and suggest that effectors are important in language learning.

The current study follows from Maouene, et al. (2008), in which it was argued that specific body region associations are important in the early development of verbs. The current study goes further to ask whether body part associations are more important for some kinds of verbs than others. Specifically, we ask whether body part associations are stronger for abstract verbs (and particularly a subgroup called light verbs or general all purpose verbs) versus concrete verbs (and particularly, highly imageable verbs and verbs associated with few object types or heavy verbs), and what relationship body parts bear with abstraction and concreteness, two fundamental concepts in verb learning. Hereafter we review the theoretical and empirical findings on the essential distinctions of abstract verbs and concrete verbs and potential routes for their connections with body region specificity.

Abstract cues in verb learning

Prior research has influentially argued that for children to learn the relational meaning of verbs, concrete, observational cues are not helpful. Instead, children rely heavily on abstract cues, particularly linguistic cues (Gillette, Gleitman, Gleitman & Lederer, 1999; Gleitman, 1990; Snedecker & Gleitman 2004). Further, it has been argued that infants toward the end of their first year can abstract the concepts found in the relational meanings of events under the form of schemas of containment and support, source, path, goal, causation, agency, etc. (see Hirsh Pasek & Michnik Golinkoff, 2006; see Mandler, 1992, for a review of experimental studies), supporting the idea that children start the process of verb learning at a general and conceptual level.

One particular class of abstract verbs that has garnered a lot of attention in the literature is the set of verbs called “light” verbs or general all purpose verbs (GAP). As there is no general agreement on what the list should encompass, we incorporated in our list those verbs that researchers have talked about as GAP verbs (e.g., Clark, 1978; Pinker, 1989; Theakston, Lieven, Pine, & Rowland, 2004) that overlap with the verbs that appear much later in development in a construction known as the light verb construction. In this particular construction, verbs which are suggested by some to be "semantically light" appear with eventive nouns such as *have* a rest, a read, a cry, a think, *take* a sneak, a drive, a walk, a plunge, *give* a sigh, a shout, a shiver, a pull, a ring, *make* a call, waste, a plan, *put* the shot, the question, blame, *bring* snow, the charge, comment, etc. In English, light verbs – and GAP verbs[†] – have been argued to have a special status by theorists of English verb acquisition (Clark, 1978; Goldberg, et al., 2004; Pinker, 1989; Theakston, Lieven, Pine, & Rowland, 2004). Because they are highly frequent, semantically general, and among the earliest produced English verbs, it has been proposed that light verbs serve an important role in verb and grammatical learning. Goldberg et al. (2004) found that several light verbs were the most frequent verbs used in particular syntactic patterns. By paying attention to this statistical regularity, children learn to associate the light verb with the syntactic pattern and learn an *abstract schema* that then facilitates the acquisition of many verbs that encode the same underlying causal and argument structure. However, see Ninio (1999a, 199b) for data showing that children use a mixture of general and specific verbs in the simple transitive and simple intransitive constructions right from the beginning, which suggests that light verbs may not have a special status in very early language development.

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 like *up*, *away*, and *off.* Clark suggests that children first produce light verbs which are very general, and later replace them with 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.

In this paper, we particularly examine whether light verbs have a special status with respect to body part associations. In the next section, we examine how concreteness is also an important factor for verb learning and examine the connection between concreteness and body part associations.

Concrete cues in verb learning

Although abstract cues are important for verb learning, concreteness has been proposed as an explanation for why some verbs are learned before others. Here we examine two specific aspects of concreteness, imageability and association with fewer object types.

Imageability refers to 'the ease with which a word gives rise to a mental image' (Paivio, Yuille & Madigan, 1968) – cited in McDonough, Song, Hirsh-

[†] Hereafter we will refer to them as light verbs although we mean an overlap between verbs appearing in the light verb construction and general all purpose verbs.

Pasek, Golinkoff, & Lannon, 2011. Imageability has been correlated with concreteness (Bird, Franklin & Howard, 2001) and has been related to a semantic notion like boundedness (Langacker, 1987): e.g., the bounded verbs *jumping*, *running*, and *eating* have clear beginning and end points, but the verb *believing* does not. It has been suggested that highly imageable words that label "perceptually accessible" concepts (a term borrowed from Gentner, 1982, 2006) are produced before those that require additional support from social or linguistic cues (Maguire, Hirsh-Pasek, & Michnick Golinkoff, 2006; Michnick Golinkoff & Hirsh-Pasek, 2008). We examine here whether verbs that are highly imageable are more strongly associated with body regions.

A second aspect of concreteness in verbs that we examine is the number of associated object types. Some authors have suggested that there is a transition from an early-restricted to a more widespread use of early verbs (Akhtar & Tomasello, 1997; Hart & Risley, 1995; Tomasello, 2003), assisted by very narrow, context–dependent (concrete) meanings. In particular, Maouene et al. (2011) have proposed to use one metric by which the 'lightness' or 'heaviness' 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. Hereafter we examine whether verbs associated with fewer object types are more strongly associated with body regions than verbs associated with more object types.

THE CURRENT STUDY

A prerequisite to a claim that body parts are important in connecting world knowledge and linguistic knowledge would be to examine whether the associations with particular body regions that were collected by Maouene et al. (2008) are equally strong on average for the majority of early-learned verbs—both concrete and abstract—or whether these associations are stronger on average for concrete verbs versus weaker for abstract verbs, or whether a more differentiated landscape emerges where the associations with body regions are strong for different groups of concrete and abstract verbs.

We compare verb/body region associative strength across three dimensions of concreteness-abstractness: light or non-light verb meanings (listed in Theakston, Lieven, Pine, J. & Rowland, 2004), less imageable and more imageable verb meanings (adult ratings given in Cortese and Fugget, 2004), and verbs used with many object types or fewer object types (listed in Maouene, Laakso & Smith, 2011). We also examine how these associative strengths are modulated by verb frequency (obtained from CHILDES) and normative age of acquisition (from the Bates-MacArthur CDI: Fenson et al., 1994).

We predict that, children's acquisition of verbs is influenced by their tie to the body such that those verbs that are more highly associated with a single region of the body (according to adults), whether concrete or abstract, are among the first acquired in vocabulary development. Further, association with a specific part of the body may be a better predictor of whether a verb is learned early than lightness or concreteness.

METHOD

Two analyses compare the strength of the association with the main body region for early-learned abstract verbs and concrete verbs. The metrics used for both analyses were the percentage of agreement among adults on a main body region with 100 early-learned verbs as given in Maouene, et al. (2008). These were obtained by asking 50 adults in an associative task to name the single body part that came to mind when they thought of each verb. For example, 100% of the participants agreed that the verbs *hear* and *listen* connect with the ear region, and 98% of the participants agreed that the verb *bite* connects with the mouth region (comprising teeth, tongue, mouth). Thus, *hear*, *listen* and *bite* have strong associations with a single main body region. By contrast, 66% of the participants agreed that *drive* connects with the hand region (comprising finger, hand, arm). Thus, *drive* has a relatively weak association with a main body region, meaning that it was associated with more than one body region across participant responses. Hence, we refer to this metric as "body region specificity" for the remainder of the paper. The regions had been determined by a dimensionality reduction technique (correspondence analysis). These are the percentages of agreement we have used here for both analyses. In our analyses, we also used the frequency of use of these 100 verbs in the productive vocabulary of children from the CHILDES database (http://childfreq.sumsar.net/, Rasmus Bååth, 2010) and the normative Age of Acquisition from the Bates-MacArthur CDI (Fenson et al., 1994) for these 100 verbs.

The first analysis looks particularly at the average body region specificity for the class of verbs named light (a subset of abstract verbs) and whether it differs for eight groups of non-light verbs, both concrete and abstract, using production frequency as the criterion to define the different groups of verbs. The second analysis examines the average body region specificity for two additional dimensions found to correlate with concreteness: imageability and number of object types. The goal was to see whether highly imageable (concrete) verbs differ from non-highly imageable (abstract) verbs in their body region specificity and whether, similarly, verbs with a low number of syntactic object types (concrete) differed from verbs with a high number of object types (abstract) on the same measure. Further, the data on body region specificity and the data on number of object types were rescaled so that they would fit on a scale from 1 to 7 (precisely the scale used for imageability judgments in Cortese and Fuggett, 2004) so as to be able to compare the distributions of the verbs between the three dimensions along concrete to abstract.

Verb list

The subset of verbs used were those listed in the Bates-MacArthur Communicative Development Inventory for American English (Fenson et al., 1994). This inventory (built from a normative study of over 1800 children) includes a list of 102 verbs that occur normatively in the productive vocabulary of at least 50% of children learning American English by 30 months of age. This list does not include the verbs such as *do, want, can, need, must,* which were categorized as "helping" verbs under another section of the MCDI. For Analysis I, all the verbs were used except two (*stay* and *tear*, verbs for which there was no data on body regions from Maouene et al., 2008). For Analysis II, 90 verbs from the MCDI were used for which there were overlapping ratings in imageability, body region specificity and number of object types (listed in the Appendix).

Body parts-verbs associations list

The body part-verb associations that underlie the body region specificity metric come from 50 undergraduate students from Indiana University whose first language was American English. They were asked to name the first body part that came to their mind in association with each of the 102 common early-learned verbs mentioned above. The list with the percentage of participants who agreed on a particular body region with a particular verb is published as an appendix in Maouene, et al. (2008). For Analysis I, we used the percentage of agreement for five regions (eye region, mouth region, ear region, leg region and hand region) as a measure of body region specificity. The associative strength of the verbs *swing* (60%), *ride* (66%) and *sit* (98%) were increased in the leg region, because we incorporated *bottom* and *butt* since it can be argued that these parts are physiologically situated in the lower part of our anatomy. For verbs that did not fit in one of those five body regions, we used the maximum agreement for one body part: for example, *fit*: 26% whole body, *love*: 26% heart, *think*: 40% mind, etc. (people have offered brain and mind as body parts and we have respected that, since we can argue that they are effectors too).

List of concrete versus abstract verbs

Two lists were built to analyze the concreteness versus abstractness of verbs: (1) A first list composed of 8 light verbs and 9 non-light verbs from the definition given by Jespersen (1954) and the list reported in Theakston, et al., 2004 (taken from Clark, 1978 and Pinker, 1989) that overlap with the list of 102 verbs from the Bates-MacArthur CDI, for which body region specificity, age of acquisition and frequencies for infants younger than 24 months in CHILDES were available (Table 1). (2) A second list includes the 90 verbs for which both imageability ratings on a 7-point-scale (Cortese and Fugget, 2004) and number of object types (Maouene et al., 2011) were available that overlap with the list of verbs from the Bates-MacArthur CDI for which body region specificity, age of acquisition and frequencies for infants younger than 24 months in CHILDES existed (see Appendix). We used Cortese & Fugget (2004) rather than Masterson & Druks (1998) because Cortese & Fugget's list contains more than twice the number of verbs (90 verbs against 44 verbs that overlap with the MCDI); see, for example, the analysis in Ma, Michnik Golinkoff, Hirsh-Pasek, McDonough, & Tardif (2008) on the imageability of 44 English verbs.

Verb frequency

The frequency of occurrence of the verbs in productive child language from the CHILDES database was used with the help of an online tool called ChildFreq (created by Rasmus Bååth, 2010). ChildFreq searches the American and British parts of CHILDES, which consist of approximately 5,000 transcriptions, in total ~3,500,000 words. We used the total number of occurrences of the verbs per 1,000,000 words from 12 to 23 months as our criterion (this projection helps compare the frequencies at different ages, because the number of transcripts varies from one age group to another). For our particular age group, it is based on 807 transcripts and 298,299 uttered words.

Age of acquisition norms

We used the norms of the children's productive vocabulary from the Bates-MacArthur Communicative Development Inventory: Toddler version (Bates-MCDI; Fenson et al., 1994). We took the age of acquisition for a verb to be the first month in which the verb is produced by more than 50% of the children.

RESULTS

This section is organized into two major subsections—one for Analysis I and one for Analysis II. Each of these two analyses was really a set of related analysis, so the subsections are divided as well. The subsection on Analysis I includes sub-subsections for Analysis I-A – Analysis I-H. Similarly, the subsection on Analysis II includes sub-subsections for Analysis II-A – Analysis II-H. The description of each of these individual analyses is divided into four parts. In the first part (Question), we elaborate on the theoretical question at stake in that particular analysis. In the second part (Method), we describe any unique features of the method for that particular analysis not already covered in the overall Method section above. In the third part (Results), we report the results of the particular analysis. In the last part (Implications), we briefly discuss the meaning and significance of the results. There are also Discussion sub-sections at the end of Analysis I and at the end of Analysis II.

Analysis I: Body Region Specificity and Lightness

The first set of analyses (collectively: Analysis I) examines whether body region specificity for the class of light verbs (a subset of abstract verbs) differs from the body region specificity of various groups of non-light verbs (both concrete and abstract). In these analyses, production frequency is used as the criterion to define the different groups of verbs. The first analysis (Analysis I-A) compared the mean body region specificity of the eight light verbs to that of eight non-light verbs where frequency was held constant. The remaining analyses (Analysis I-B – Analysis I-H) compared the mean body region specificity of the eight light verbs to the mean body region specificity of eight different groups of verbs defined by frequencies of occurrence in CHILDES for 12- to 23-month-old infants. In these analyses, we also checked whether each group of verbs by frequency differed significantly from the light verb group in terms of age of acquisition based on parental report (Fenson, et al., 1994). In the following analyses, none of the 96 verbs present in the speech of 11-to 23 month-olds were analyzed twice.

Analysis I-A: Light verbs compared to most frequent non-light verbs

Question. Our overall question in Analysis I was whether the body region specificity of light verbs differs from that of non-light verbs. Thus, the first analysis simply compares the mean body region specificity for the eight light (abstract) verbs to the mean body region specificity for the eight most frequent concrete early-learned verbs.

Method. We used the total number of occurrences per 1,000,000 words from 12 to 23 months as our criterion of frequency. These occurrences appear in brackets for the 16 verbs listed below. For the light verbs, the list includes *make* (838), *put* (2903), *take* (1334), *have* (1890), *go* (5547), *give* (606), *get* (2701) and *bring* (150). The most frequent verbs that are both non-light and non-abstract did not include *like, help* or *play* because these are semantically general. The list includes: *close* (1024), *drink* (811), *eat* (1521), *look* (2933), *open* (1813), *read* (1441), *see* (3121) and *sit* (1884).
Results. A *t*-test indicates that the mean frequency of occurrence of the light verb group, M=1996, SD=1734.5 did not differ from the mean of the concrete verbs with the highest frequencies, M=1818.5, SD=829.8, $t(14)$=0.26, p=.79. Furthermore, the mean body region specificity for the eight light verbs, M=89.3, SD=9.8, does not differ significantly from the mean body region specificity for the eight non-light verbs, M=90.0, SD=10.5, $t(14)=-0.14$, p=.88. However, the two types of verbs differ significantly in terms of their age of acquisition: light verbs, M=24.12, SD=2.6, and non-light verbs, M=21.5, SD=2.0, $t(14)$=2.24, p=.042.
Implications. The most frequent concrete verbs are approximately as frequent as the light verbs. Moreover, the body region specificity of the concrete verbs is approximately the same as that of the light verbs. However, the eight light verbs appear later than the eight most frequent concrete verbs in the productive vocabulary of this sample of young children. In other words, eight highly *concrete* verbs with high frequency are acquired earlier in CHILDES (downloaded June 2011), than the eight *light* verbs of equally high frequency usually proposed as quite abstract verbs (Pinker, 1989; Clark, 1978; Theakston et al., 2004, etc.). Interestingly, these two groups did not vary significantly in their average body region specificity.

Analysis I-B: Light verbs compared with low-frequency verbs

Question. In Analysis I-B – Analysis 1-H, we examined the relationship between frequency, body part specificity and age of acquisition. In Analysis I-B in particular, we wanted to know whether the eight light verbs differed from low-frequency non-light verbs in terms of body region specificity or age of acquisition.
Method. For Analysis I-B – Analysis 1-H, we began by grouping the non-light verbs by frequency such that each group has a similar number of verbs. We divided the non-light verbs into seven groups based on production frequencies (occurrences per 1,000,000 words) at 12 months. Two groups contained verbs that had fewer than 100 occurrences per 1,000,000 words. These two groups differed in the pattern of frequency of their verbs at later ages. One of them contained verbs that remained infrequent, whereas the second contained verbs that—although initially infrequent—rose in frequency over time. A third group had verbs that occurred

between 100 and 200 times per 1,000,000 words. The fourth group had verbs that occurred between 200 and 300 times per 1,000,000 words. The fifth group had verbs that occurred between 300 and 400 times per 1,000,000 words. The sixth group had verbs that occurred between 400 and 600 times per 1,000,000 words. Finally, the seventh group contained the remaining verbs with more than 600 occurrences per 1,000,000 words. For all these, we also computed the relation of each group to age of acquisition.

Analysis I-B specifically compared the eight light verbs and the 12 verbs that have the lowest frequency (fewer than 100 occurrences per 1,000,000 produced words) between 12 and 23 months and that stay below a hundred occurrences in child speech until 60 months. These verbs are: *clap* (53), *feed* (77), *lick* (30), *rip* (0), *shake* (67), *share* (13), *skate* (0), *chase* (100), *smile* (16), *spill* (53), *splash* (73) and *sweep* (67).

Results. The mean body region specificity for the eight light verbs, *M*=89.3, *SD*=9.8, does not differ significantly from the mean body region specificity for the twelve concrete and later-learned verbs (from CHILDES), *M*=86.12, *SD*=12.35, $t(18)=0.62$, $p=.54$. And again, the two groups differ significantly in terms of age of acquisition, but this time, the light verbs are earlier acquired, *M*=24.12, *SD*=2.6, whereas the verbs that are less frequent at subsequent ages are acquired significantly later, *M*=27.33, *SD*=2.1, $t(18)=-3.02$, $p=.007$.

Implications. Light verbs like *make, put, go,* etc., with the highest frequencies (range between 800 and 5447 occurrences per 1,000,000 words) are acquired significantly earlier than a group of concrete verbs with very low frequencies (below 100 occurrences). This result supports the idea that frequency plays a major role in verb acquisition (Goodman, Dale & Ping, 2008).

Analysis I-C: Light verbs compared with verbs with increasing frequency

Question. We wanted to know whether the comparison to light verbs fared any differently among low-frequency verbs with increasing frequency at later ages compared to low-frequency verbs that remain low at later ages.

Method. The third comparison compared the eight light verbs to the ten verbs that have the lowest frequency (fewer than 100 occurrences per 1,000,000 words) at 12 to 23 months and which occur more and more frequently at 24 months and 36 months. These verbs are: *break* (54), *cook* (92), *finish* (77), *hate* (0), *hit* (67), *hear* (13), *hurry* (13), *pour* (11), *pretend* (97) and *wish* (26).

Results. Here, interestingly enough, the results indicate that the body region specificity for the eight light verbs, *M*=89.3, *SD*=9.8, differs significantly from the body region specificity for the 11 later-learned verbs, *M*=68.8, *SD*=28.73, $t(11.49)=2.10$, $p=.04$ (two-tailed, equal variance not assumed, Levene's test is significant, $F=27.29$, $p<.01$). And here, the two groups do not differ significantly in terms of age of acquisition, but there is a marginal tendency for the light verbs to be acquired earlier, *M*=24.12, *SD*=2.6, over the infrequent verbs, some concrete some abstract, *M*=26.7, *SD*= 2.1, *t*(16)=−1.91, *p* =.074.

Implications. Among the groups of verbs with the lowest frequencies, the subsample of 10 verbs with low frequencies that are later-learned (a subgroup of the "new comers" in CHILDES) was not well learned. Moreover, these verbs differ significantly from the light verbs in that they had, on average, lower body region specificity, that is, their meaning related to more than one main body region.

Analyses I-D – I-H: Light verbs compared to more frequent verbs

Question. Having examined the relationship between light verbs and two groups of low-frequency verbs in Analysis I-B and Analysis I-C, we were also interested in comparing light verbs with the remaining five groups of relatively high-frequency verbs in terms of body part specificity and age of acquisition.

Method. The method was the same as used in Analysis I-B and I-C, but these analyses each used one of the remaining five groups of verbs by frequency.

Results. The next four groups did not differ significantly in terms of mean body region specificity or age of acquisition. However, the last group, which has the highest frequencies, *draw* (660), *help* (693), *push* (737), *fix* (750), *fall* (848), *find* (848), *like* (1317) and *play* (1880) (*M*=966.6, *SD*=423.2) per 1,000,0000 words showed a marginally significant difference when compared with the light verbs. The mean body region specificity for the eight light verbs, *M*=89.3, *SD*=9.8, differed marginally from the mean body region specificity for the eight verbs with the highest frequencies: *M*=69.00, *SD*=27.8, *t*(14)=1.93, *p*=.074. Table 1 summarizes the tests performed in Analysis I-A – Analysis I-H.

Implications. There is a (marginally significant) tendency for the group of verbs with frequencies in the 600 and up per 1,000,000 to differ from the light verbs in terms of body region specificity. This result seems to confirm that a unique and strong association between the verb and a single body region is helpful for toddlers, and that frequency may not explain all of the acquisition data, because those verbs were very frequent too.

Table 1.
A summary table of the eight comparisons in Analysis I. Each of the predominately white rows shows data from one of the analyses reported above. The first white row shows data from Analysis I-A, the second white row shows data from Analysis I-B, and so on. The last white row shows data from Analysis I-H.

	Mean body part percentages	SD	t value	P value for t-test	Mean AoA MCDI (50% agreement) in months	SD	P value for t-test	Verbs In bracket is the projected number of occurrences for 1,000,000 words between 12 and 24 months
8 light verbs	89.3	9.8			24.12	2.6		make (838), put (2903), take (1334), have (1890), go (5547), give (606), get (2701), bring (150)
8 most frequent and concrete verbs	90.	10.47	t(14)= -.14	non-significant	21.5	2.0	.04*	close (1024), drink (811), eat (1521), look (2933), open (1813), read (1441), see (3121), sit (1884)
12 verbs below 100/1,000,00 occurrences and no increase	86.12	12.35	t(18)= . 62	non-significant	27.3	2.1	.007**	clap, feed , lick, rip, shake, share, skate, chase, smile, spill , splash , sweep
10 verbs below 100/1,000,000 and increasing	68.8	28.73	t(11.49)= 2.10	.04*	26.7	2.1	marginally significant .074	break , cook, finish, hate, hit, hear, hurry, pour , pretend , wish
23 verbs with frequencies in the 100 range	80.00	17.7	t(16)= 1.28	non-significant	24.6	3.04	non-significant	Blow, bring, build, buy, carry, climb, cover, dance, drive, dry, hug, kick, knock, listen, love, run, show, sing, stand, tickle, touch, wait, wipe
10 verbs with frequencies in the 200 range	81.00	16.00	t(15.13)= 1.35	non-significant	24.8	3.05	non-significant	Bite, cry, drop, dump, hold, pick, stop, throw, wake, work
11 verbs with frequencies in the 300 range	77.8	24.2	t(13.13)= 1.41	non-significant	24.00	2.76	non-significant	Bump, catch , kiss , paint, ride , swing , walk , wash, talk, think, watch
8 verbs with frequencies in the 400 to 500 ranges	78.5	26.7	t(8.89)= .31	non-significant	25.37	2.45	non-significant	Cut, fit pull, say, sleep write, clean, jump
8 verbs with frequencies above the 600 range	69.00	27.8	t(14)= 1.93	marginally significant .074	23.75	2.8	non-significant	Draw (660), help (693), fix (750), push (737), fall (848), find (848), like (1317), play (1880)

* significant (2-tailed), $p < .05$ and ** significant (2-tailed), $p < .01$

Discussion. In Analysis I, the series of independent *t*-tests examining the frequencies in CHILDES (at 12 to 23 months) of the group of eight light verbs compared to the eight groups of verb frequencies in CHILDES indicates that seven groups of verbs out of eight were not significantly different in terms of average body region specificity. The only group of verbs that was significantly different from the light verbs was the one with a frequency below 100 occurrences per 1,000,000 words with a growth trend at later ages. This group had on average lower body region specificity, meaning these verbs were related to multiple body regions. In fact, these verbs happened to be acquired significantly later than the light verbs, which in turn were acquired significantly later than the highly frequent and concrete verbs. Following the results in Analysis I, we can make new differentiations: eight highly *concrete* verbs with high frequency are acquired earlier in CHILDES (downloaded June 2011), than the eight *light* verbs of equally high frequency usually proposed as quite abstract verbs (Clark, 1978; Pinker, 1989; Theakston et al., 2004, etc.). Interestingly, these two groups did not vary significantly in their average body region specificity. The next result indicates that light verbs like *make, put, go,* etc., with the highest frequencies (range between 800 and 5447 occurrences per 1,000,000 words) have a significant difference in body part associations from a group of concrete verbs with very low frequencies (below 100 occurrences) that are not increasing much in frequency at later age; this later group of verbs have a marginal significance in age of acquisition with the light verbs, which supports the idea that frequency combined with body part associations can help differentiate between subtypes of concrete verbs. Finally, there is a tendency for the group of verbs with frequencies in the 600 and up per 1,000,000 to differ from the light verbs in terms of body region specificity (marginal significance). This result seems to confirm that a unique and strong association between the verb and a single body region is helpful for toddlers, and that frequency may not explain all of the development (Goodman, Dale & Ping, 2008), because those verbs were very frequent too. Finally, among the groups of verbs with the lowest frequencies, a group was not well-learned. It corresponds to a subsample of 10 verbs, the verbs with low frequencies that are later-learned, a subgroup of the "new comers" in CHILDES, and these verbs differ significantly from the light verbs in that they had, on average, lower body region specificity, that is, their meaning related to more than one main body region.

Analysis II: Body Region Specificity and Concreteness

Analysis II-A: Correlations with body region specificity

Question. To explore further how body region specificity relates to concreteness and abstraction in early verbs, we used imageability, a criterion previously found to help English children in verb acquisition (McDonough et al., 2011), and object type associations (Maouene et al., 2011), a criterion that allows characterization of the verbs as more concrete or more abstract along a continuum and aligns with the distinction between light and non-light verbs.

Method. We used Cortese & Fugget (2004)'s list of verbs with imageability ratings from adults and Maouene et al.'s list of verbs (2011) with number of object type associations from adults for which we had body region specificities from Maouene et al. (2008). We took all the verbs from the CDI list that were present in the three above mentioned studies, a total of 90 verbs. We then checked whether these measures correlated with the body region specificity of each verb and whether imageability and number of object types correlated with each other.

Results. Body region specificity did not correlate significantly with any of the variables tested: neither with imageability nor with number of object types, frequencies of production of the verbs by toddlers in CHILDES or age of acquisition from the Bates-MacArthur CDI across the 90 verbs. This result is expected since we argue that most concrete and abstract verbs have quite strong body region specificity. Interestingly, the two other measures of concreteness correlated significantly and negatively with each other: $r(88)=-0.59$, $p<.05$, such that the more imageable a verb is rated, the fewer object types this verb is associated with. The correlations are reported below in Table 2.

Table 2.
Correlations between imageability, number of object types, agreement on a body region, age of acquisition and frequencies in CHILDES

	image	object types	body regions	AoA	freqchildes
image	1				
object types	-.586*	1			
body regions	0.09	-0.071	1		
AoA	-0.148	.238*	-0.175	1	
freqchildes	-.432*	.235*	0.117	-.319**	1

Implications. The results indicate that there is no simple linear correlation between body region specificity on one hand and imageability and number of object type associates on the other hand.

Analysis II-B: Calculating difference scores

Question. We know from Maouene et al. (2008) that there is a wide range of body region specificities. Agreement among participants that a verb is associated with a main body region ranges from 26% to 100%. We wanted to be able to compare the distribution of body region specificity to the distributions of imageability and number of object types. We also wanted to compare particular segments of the distribution to come up with a more precise description of different groups of concrete and abstract verbs. The overall goal was to specify the landscape in terms of concreteness and abstraction. To that effect, we rescaled the data on body region specificity together with the data on number of object types so that each would fit on a scale from 1 to 7 (precisely the scale used for imageability judgments by Cortese & Fuggett, 2004).

Method. We proceeded as follows: for body region specificity, we took 100% of agreement on a body region for a particular verb to be equivalent to 7, the maximum score on the scale, so that 1 corresponds to no agreement on a single body region for a particular verb and 7 means everybody agreed on a single body region for that verb. For number of object types, we took the highest number of object types associated with a verb, 141 (that is 141 object types were associated with the verb *take*), and made that the maximum of the scale, or 7.

Consider, for example, the verb *bite*. It had 98% of participants agreeing (on the mouth region), 66 types of objects associated, and an imageability rating of 5.2 on a seven-point scale. After the rescaling, it has a body region specificity index of 6.86 and a diversity of object types index of 3.28, on the same seven-point scale. All the new values obtained from the rescaling are reported in the Appendix. We then summed the three indices of concreteness and averaged them into a unique composite index of concreteness ranging from 1 to 7 for the 90 verbs.

We reasoned that comparing the body region specificity index (B) of each verb to its composite concreteness index (C) by subtracting the composite concreteness index from the body region specificity index to obtain a comparative difference score (D=B–C) would allow us to classify the verbs. In that case, a negative difference score would mean the verb has low body region specificity relative to its concreteness, while a positive difference score would indicate that the verb has high body region specificity relative to its concreteness. For example, the verb *hate* has a body region specificity index of 2.33 (which corresponds to 40% agreement on mind, rescaled on the seven-point scale) and a composite concreteness index of 3.93 (the average between imageability, number of object types and body region specificity), so the difference score is −1.6, which places *hate* among the most abstract verbs in terms of body region specificity.

Results. We found that some verbs had body region specificity indices that were lower than their composite concreteness indices (negative difference scores), that some verbs had body region specificity indices at the same level as their composite concreteness indices (negligible difference scores), and that most verbs had body region specificity indices that were greater than their composite concreteness indices (positive difference scores). We then graphed the curve, with the difference score on the y-axis and the verbs ordered by this value on the x-axis. The graph obtained by this method is shown in Figure 1.

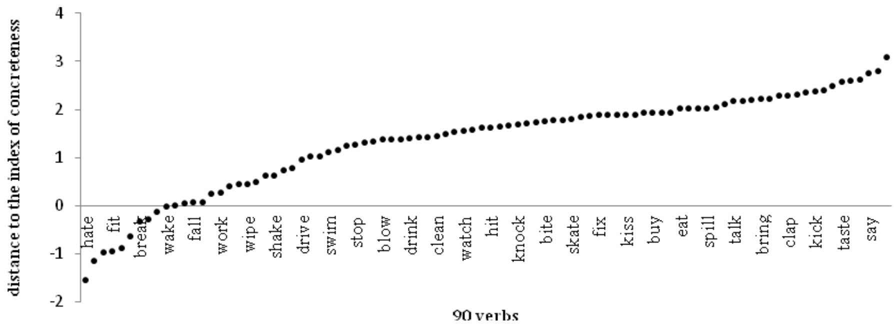

Figure 1.
The distribution of the 90 early-learned verbs (all 90 are plotted, but only a subsample of them are labeled here) ordered by the difference, for each verb, between its body region specificity index and its composite concreteness index, composed of imageability, object types and body region specificity.

The results indicate that most verbs, 80 verbs out of 90, have positive difference scores. That is, each of these 80 verbs has a body region specificity index greater than its composite concreteness index.

Implications. This result confirms our hypothesis that most verbs in this sample have strong associations with a main specific body region. The results further show that only 10 verbs had negative difference scores, that is, had low body region specificity indices relative to their composite concreteness indices. Among those, we have abstract verbs such as *hate, play, think, hide, show* and *love*—where the body region is hidden (*heart, mind, brain*) and where multiple body regions come into play, particularly the eye-brain, eye-heart, and eye-hand regions. We also find concrete verbs such as *fit, bump, break* and *wake,* verbs that can be used reflexively with many body parts (you can break your leg, your toes, your arm, etc.) or with the whole body; however, as can be seen, none of the light verbs belong to this list of ten abstract verbs. These results confirm the results of our first analysis—that the light verbs have high body region specificity even though they are considered abstract. These results further suggest that different groups of abstract verbs co-exist: those with higher body region specificity and those with lower body region specificity, along a continuum, and likewise for concrete verbs.

Analysis II-C: Grouping by difference scores

Question. Having determined through Analysis II-B that it might be possible to use difference scores to subdivide both abstract and concrete verbs into groups with high body region specificity and low body region specificity, we wanted to be able to compare the resulting groups.
Method. We divided the verbs into four categories based on the difference scores: (1) all the verbs with negative difference scores, a group of 10 verbs; (2) the verbs whose difference scores fall between 0.01 and 1.0, a group of 15 verbs; (3) the verbs whose difference scores fall between 1.01 and 2.0, a group of 41 verbs; and (4) the verbs with difference scores greater than 2.0, a group of 24 verbs.
Results. The independent samples Kruskal-Wallis test on the difference scores indicates that the mean rank (MR) for the negative range is MR=7.25, for the range from 0.1 to 1.0 is MR=17.73, for the range from 1.01 to 2 is MR=49.91 and for the range above 2.1 is MR=71.25, and that the distribution of the difference score across the four categories of ranges varies significantly, such that H=7.89, 3 df, p<.05.
Implications. We can order the verbs along an axis of concreteness where the 'negative pole' includes verbs with low body region specificity, low imageability and high object type diversity, and where the 'positive pole' includes verbs with high body region specificity, high imageability and low object type diversity. This last result suggests that, if we do so, then two groups of abstract verbs and two groups of concrete verbs can be discerned, and they are all different from each other in terms of their difference scores. This structure can only be unveiled when using groups with different numbers of verbs because the vast majority of the verbs lie in the middle of the continuum.

Analysis II-D: Age of acquisition and difference scores

Question. In Analysis II-D – Analysis II-G, we take a closer look at subgroups of verbs along this continuum of difference scores and examine how they relate to age of acquisition, frequency, imageability and diversity of object types. We begin in Analysis II-D with age of acquisition.
Method. We took the number of new verbs produced at each of the twelve ages from 19 months to 30 months, by 50% of the children, according to parental report (CDI, Fenson et al., 1940), and we computed the mean difference score at each age. As can be seen in Table 3, the early verbs (ages 19 and 20 months) look different from the middle verbs (22 to 28 months) and from the late verbs (29-30 months).
Results. The independent samples Mann-Whitney test indicates that the mean rank, MR=11.22, for the 9 verbs learned between 19 and 20 months, differs marginally from the mean rank, MR=6.05, for the 8 verbs learned at 21 months, with SE=10.39,

such that U=16, z=−1.92, p=.059, two-sided. The trend is significant when we compare the 9 earliest verbs with a mean rank, MR=14.67, and the 12 latest verb distributions at 29 and 30 months, where the mean rank is MR=8.25, with SE=14.07, and U=21, z=−2.34, p= .018, two-sided.

Implications. Taken together, these results shed light on why we did not find a correlation between age of acquisition and body region specificity: the vast majority of the verbs have similar distributions except at the very beginning and at the very end of the age of acquisition curve. In sum, these results suggest that there is a trend for body region specificity to weigh more relative to the composite concreteness index for very early acquired verbs (between 19 and 21 months) compared to the verbs acquired at 22 months and a significant difference between those very early learned verbs and the latest acquired verbs. All the light verbs are situated between the 2nd rank (*go* at 19 months) and the 55th rank (*have* at 26 months) on the difference score curve, so that none of them are late-acquired verbs. Further, they have a mean difference score of M=1.87, SD=0.45, which places them close to the highest weight in body region specificity. This also replicates the findings of Analysis I, where this particular group of abstract verbs was found to have high body region specificity. Table 3 presents the mean difference scores ordered by monthly age of acquisition from 19 to 30 months and the standard deviations.

Table 3.
Average difference scores (mean distance) ordered by monthly age of acquisition from 19 to 30 months (the verbs and their normative age of acquisition are from Fenson et al., 1994)

Age categories	nineteen	twenty	twenty-one	twenty-two	twenty-three	twenty-four	twenty-five	twenty-six	twenty-seven	twenty -eight	twenty-nine	thirthy
Nr of verbs	3	0	6	8	19	3	12	15	12	0	5	7
Mean Distance	2.34	0	1.91	1.11	1.31	1.77	1.16	1.45	1.58	0	0.95	0.62
SD	0.3		0.37	0.94	0.96	1.15	1.13	0.73	0.84	0	1.36	1.25

Analysis II-E: Frequency and difference scores

Question. Having examined age of acquisition in Analysis II-D, we turn to frequency in Analysis II-E. We want to know whether there is a systematic relation between difference scores and frequency.

Method. We took the number of verbs occurring at the same frequencies for seven different frequencies, so as to have groups with roughly the same number of verbs per group and similar groups to the ones under Analysis I. Some groups were formed in increments of 100 occurrences per 1,000,000 utterances (0 to 99, 100 to 199, 200 to 299, and 300 to 399). The other three groups comprised verbs with 400 to 599, 600 to 999 and 1000 or more occurrences.

Results. As can be seen in Table 4, the most frequent verbs have a tendency to have larger difference scores than the least frequent, but this is only a trend. We would

need more new verbs lately acquired to see if this trend would persist, get reinforced or disappear. A Mann-Whitney test comparing the difference scores of verbs with frequencies greater than 600 (= the highest frequencies, 22 verbs) to those of verbs with frequencies below 100 (= the lowest frequencies, 19 verbs) was not significant.
Implications. These results seem to confirm the results of Analysis I whereby frequency relative to the other dimensions of concreteness does not by itself discriminate abstract from concrete verbs, while they help with learning (see Table 2). Table 4 below shows the different means and standard deviations for each group of frequencies in terms of the difference score between body region specificity and composite concreteness.

Table 4.
Average difference scores (mean distance) ordered by groups of productive frequencies in childes (toddlers from 12-to 23-months)

occurrences	>1000	600-900	400-599	300-399	200-299	100-199	<100
Nr of verbs	12	10	8	11	10	21	19
Mean Distance	1.54	1.64	1.37	1.19	1.38	1.34	1.2
SD	1.06	0.68	1.24	1.14	0.73	0.79	1.15

Analysis II-F: Imageability and difference scores

Question. To further our description of the difference between subgroups of verbs in terms of other correlated dimensions of concreteness, we want to know whether there is a systematic relation between difference scores and imageability.
Method. We checked the difference score when we order the verbs from most imageable (7) to least imageable (1). We took the verbs occurring at each interval of 1 on the scale from 1 to 7 and averaged their difference scores.
Results. As can be seen in Table 5, a U-shaped curve seems to emerge from that distribution, where the sections of the distribution ordered by the most imageable verbs and the least imageable verbs do not differ. Among the least imageable verbs, according to adult judgments (Cortese and Fugget, 2004), are all the light verbs. These fall on the interval from 1 to 2.9, confirming that these abstract verbs have as strong body region specificity as the most imageable and thus concrete verbs. They have a mean difference score of M=1.87, SD=0.45 whereas the other, least imageable and abstract verbs, such as *help, say, like, wait, think* and *find,* in those same intervals, have a mean difference score of M=1.02, SD=1.02, confirming two types of abstract verbs. For the concrete, most imageable, verbs, we find that 60 of them populate the intervals going from 4 to 4.9, 5 to 5.9 and 6 to 7, and they do not

differ in terms of their difference scores. However, they differ significantly from the group of 13 verbs that are on the interval from 3 to 3.9 in terms of their mean difference score. These verbs might be seen as overall less imageable from an adult perspective, or transitioning towards abstraction. They are *work, look, build, dry, pick, close, hide, buy, hear, share, fit, fix, see, hate* and *wish.*
Implications. In brief, a main group of 60 imageable verbs and 30 less imageable verbs populate these intervals of imageability. Two different groups of "abstract" verbs emerge in terms of imageability: the light verbs with strong body region specificity and the abstract non-light verbs with weaker body region specificity. Table 5 presents the mean difference scores ordered by an interval of one increment on the scale from 1 to 7 and the standard deviations.

Table 5.
Average difference scores (mean distance) ordered by imageablity intervals

Imageability ranges	6 to 7	5 to 5.9	4 to 4.9	3 to 3.9	2 to 2.9	1 to 1.9
Nr of verbs	3	24	33	16	12	2
Mean Distance	1.5	1.5	1.34	0.99	1.54	1.64
SD	0.44	0.66	1.02	1.3	0.96	0.28

Analysis II-G: Diversity of object types

Question. To describe further the difference between subgroups of verbs in terms of another correlated dimension of concreteness, number of object types (Maouene et al., 2011), we want to know whether there is a systematic relation between difference scores and number of object types.
Method. We checked the difference scores when we order the verbs from many object types (7), or abstract verbs, to few object types (1), or concrete verbs. We took the verbs occurring at each interval of 1 on the scale from 1 to 7 and averaged their difference scores.
Results. As can be seen in Table 6, a trend seems to emerge from that distribution where the average difference score for the verbs with fewer object types differs from the average difference score for the verbs with more object types. An independent samples Mann-Whitney test indicates that the mean rank for the 12 verbs that take the most object types (abstract verbs on the intervals 6 to 7 and 4 to 4.9), MR=14.33, and the mean rank for the 24 verbs that take the fewest object types (concrete verbs on the interval 1 to 1.9), MR=20.58, with SE=29.79, differ marginally such that U=94, z=−1.68, p=.091, two-sided. The trend is significant when we compare the 12 verbs that take the most object types (intervals 5 to 6 and 4 to 4.9), with a mean rank MR=15.04 with the 29 verbs with the fewest number of

object types (interval 2 to 2.9), where the mean rank is *MR*=23.47, with *SE*=34.89, and *U*=102.5, *z*=−2.05, *p*=.039, two-sided.

Implications. It is thus the case that a small group of 12 abstract verbs, those verbs that are associated with the highest number of object types by adults, have smaller difference scores than a group of 29 concrete verbs. In fact, the distribution tends to bi-modalilty: a group of 37 more abstract verbs associated with many different objects and a group of 53 more concrete verbs associated with fewer objects tend to differ in their mean difference scores. Here the light verbs fall on four intervals: from 6 to 7 (1 verb), 4 to 4.9 (4 verbs), 3 to 3.9 (2 verbs) and 2 to 2.9 (1 verb); this dimension seems to separate between them more. However, within the group of 12 abstract verbs, the light verbs have larger difference scores, *M*=1.77, *SD*=0.45, than the other verbs in this group, *M*=0.26, *SD*=1.1, such as *break, help, work, show, pick, find* and *hate.*

Analysis II-H: Transitivity

Question. Since this dimension of concreteness is about objects, we looked at the proportion of verbs that are mostly transitive and mostly intransitive in those four groups of verbs.

Method. We used data from the Merriam-Webster on-line dictionary at http://www.merriamwebster.com/dictionary/ because this dictionary makes a clear separation between the transitive and intransitive uses of each verb. Our criterion was whether the verb was first listed with its transitive or intransitive meanings. For example, under a verb like *bite*, the dictionary first listed all the transitive entries and second the intransitive ones, whereas for a verb like *climb*, the order was reversed.

Results. Interestingly, within the group of 37 verbs that ask for many objects, the group of 12 verbs (interval 6 to 7, no verb interval 5, and interval 4 to 4.9), the mean proportion of intransitive verbs is lower, *M*=0.08, than for the next group of verbs, *M*=0.36. This observation is also valid for the group of 53 object-narrow verbs, where the group of 24 verbs with the fewest object type associates have a higher proportion of intransitives, *M*=0.33 (interval 1 to 1.9) than the other group of 29 object-wide verbs, *M*=0.10.

Implications. In brief, we find interesting subdivisions in terms of percentages of intransitives within the two main groups of 53 object-restricted verbs and the two groups of 27 object-non-restricted verbs that populate these intervals of object types. Two different groups of “abstract” verbs emerge in terms of objects: the light verbs with higher difference scores, which also have a lower proportion of transitive verbs, and the abstract non-light verbs with lower difference scores and a higher proportion of intransitive verbs. Similarly, two different groups of “concrete verbs” can be described: they have similar difference scores, but the group of verbs with the least number of object associates has a higher percentage of intransitive verbs (interval 1 to 1.9) than the second one (interval 2 to 2.9). Table 6 presents the mean difference scores ordered by the number of object type associates on an interval of one increment on the scale from 1 to 7 and the standard deviations.

Table 6.
Average difference scores ordered by object type intervals

object types	6 to 7	5 to 5.9	4 to 4.9	3 to 3.9	2 to 2.9	1 to 1.9
Nr of verbs	2	0	10	25	29	24
Mean Distance	-0.1	0	1.09	1.05	1.64	1.55
SD	2.02	0	0.96	1.09	0.76	0.79

DISCUSSION

In sum, even in the analyses with the larger set of 90 verbs, the verbs picked out as abstract (including the light verbs) versus concrete did not differ reliably in terms of body region specificity. There were no reliable differences for any of the examined measures. Neither were there any reliable differences based on whether the verbs are concrete or abstract, by three different indicators of abstractness: children's productive frequency between 12 to 23 months in CHILDES, adults' imageability ratings, and number of types of associated objects. Thus, it appears that early light verbs are as strongly associated with specific body regions as early non-light verbs; that low-imageable verbs are as strongly associated with specific body regions as high-imageable verbs; and that verbs with many object type associations are as strongly associated with specific body regions as those with fewer object type associations.

However, a more differentiated picture emerges when subgroups of concrete and abstract verbs are analyzed separately. Frequency does not separate well between abstract and non-abstract verbs, but it helps with learnability (Analysis I and correlations in Analysis II). Small groups of very early-learned verbs and very late verbs have different distributions in terms of body region specificity (analyses I and II). Imageability and number of object types correlate negatively and significantly with each other, increasing our understanding of what it means for a verb to be concrete or abstract. The distribution of the average difference scores ordered by the imageability intervals forms more of a U shape, whereas the distribution of the average difference scores ordered by object type intervals tends to look more like a bi-modal distribution.

Within these distributions, the difference score varies for some subgroups of concrete and abstract verbs. For imageability, very imageable (concrete) and very non imageable (abstract) verbs do not vary; only a subgroup of 19 verbs situated on the interval of 3 to 3.9 tends to do so. For number of object types, a small group of 12 verbs with the highest number of object type associates varies significantly from a larger group of concrete verbs that have a low number of object associates. Within the concrete verbs and the abstract verbs, we find also interesting differences, such as the difference between the light abstract verbs and the non-light abstract verbs (imageability) and the proportion of transitive verbs (number of object types) that differ both within concrete verbs and within abstract verbs.

GENERAL DISCUSSION

In developmental cognitive science there has been increasing discussion as to whether the developing language may be better understood in its relation to the physicality of the body, in real-time, and in a physical world (Adolph, 2010; Iverson, 2010; Smith, 2010; see Samuleson, this issue). This idea is sometimes referred to as the embodiment hypothesis. Similarly, in the research with pre-linguistic infants, a shift in focus is perceptible where researchers study more and more *how* language emerges in human infants from its network of connections with the whole event rather then just from parental linguistic input (see Dueker, Portko & Zelinsky, this issue). Thus, from the embodiment perspective, although the language stimulus is arguably poor in the beginning (Pinker, 1984), the connections including—but not restricted to—the infant's and the caregiver's body and body parts, are extremely rich and are claimed to provide a decisive scaffolding for language acquisition (Bahrick, Flom & Lickliter, 2002; Baldwin, Markman, Bill, Desjardins & Irwin, 1996; Butterworth & Itakura, 2000; Campbell & Namy, 2003; Hoff, 2006; Kelly, 2001; Lewkowicz, 1998a,b; Pereira, Smith & Yu, 2008; Tomasello, 1999; Trautman & Rollins, 2006).

In our particular domain concerned with the early acquisition of verbs, the literature has mainly focused on lightness (a type of abstraction commonly operationalized by frequency) and concreteness (operationalized by imageability ratings and number of associated object types) as the principle drivers of acquisition, whereas the results presented here point to a more embodied perspective of word learning. As such, this study provides two main contributions: 1) The verbs that are more highly associated with a single region of the body, according to adult judgments, are among the first acquired in vocabulary development; 2) Associations with a specific region of the body may be a better predictor of whether a verb is learned early than the concreteness or abstractness of the verb.

The present finding that the verbs that are more highly associated with a single region of the body, according to adult judgments, are among the first acquired in vocabulary development is quite puzzling. Why would strength in associations on one main body region—according to adult judgments—help acquisition?

One possible argument is that adults use their knowledge of verbs in their speech to children, so children hear regularities and associations that are structured by adult knowledge. This study cannot claim more than that, but our ongoing work seems to point in that direction: Examining in 36 corpora of CHILDES the occurrences of body parts terms immediately before and immediately after the same early-learned verbs from the MCDI, our results indicate that respectively 21% (before) and 26.8% (after) of the verbs co-occur at least once with a body part in the speech of 24 month-olds and these percentages are respectively 39% (before) and 26.8% (after) in the speech of parents to their 24-month-old children (Maouene, Laakso & Smith, in preparation). These preliminary results seem to indicate that using the adult metrics of body parts associations to verbs—because they share the same structure of a body that the children do—is a meaningful and stable enough set of constraints. Further, although nothing tells us in this data that it is learning about the child, we can argue that there is something powerful about the effectors in terms of their role of ubiquitous references. When asking children, "What body part do you use when you bite", there is little chance that children will answer *leg*, *ear* or *eye*. Preliminary results indicate that indeed for 20 children interviewed, 64% answered *mouth* and 36% *teeth*, a result that is as strong as adult associations (Maouene & Maouene, in preparation).

Further, children could be helped because the strength in associations reflect the probability of a specific effector to occur in a particular action the verb refers to and thus emerge as a solid predictive cue. For example, when we compare the nine verbs that are learned the earliest according to the MCDI (*bite, drink, eat, kiss, go, sit, watch, hug*) with the ten verbs that have a negative difference to the composite index (*hate, play, think, hide, show*, *love*, *fit, bump, break*, *wake*), we find that that the actions that have a more distributed combination of effectors (*fall: leg-whole body, break: leg-arm-back, think: mind-eye-head, pretend: eye-hand-mind, etc.)* are learned later. We also have indications that "visualizability" of the effectors might matter: *brain, mind, heart* are hidden and thus could explain partly why the cognitive verbs and emotional verbs are learned later (*like, love, hate, think*). Additionally, among the verbs with a negative distance are actions that allow for a self-directed use of many body parts or regions like *break, bump* (you can *bump* and *break* a lot of different body parts), or where the whole body seems to be involved (*fit, wake*) and speaks to the lack of a strong predictive cue. However, a common objection could be that associations are a product of learning rather then driving learning. The present data cannot address this issue in and of itself, but experimental studies with fetuses and computer simulations might help shed light on this long-standing question.

Finally, one could object to the embodiment claim presented here, that although the present results tell us that mature speakers strongly agree in their associations with one main body region for most concrete and abstract verbs, they do not tell us how, or whether, that knowledge is used in meaning comprehension. We certainly need more experimental work, but different imagery data in adults (Hauk, Johnsrude, & Pulvermüller, 2004) and in children (James & Maouene, 2009) indicate that reading verbs or hearing them activate regions of the associative motor cortex selectively for leg verbs, hand verbs and mouth verbs. Further, with novel verbs and novel actions, only manipulation (action) but not observation creates connections in the brain between the auditory cortex and the sensori-motor cortex (James & Swain, 2011). In brief, the first analyses presented here suggest that there is enough ground to start considering body part correlations as a possible variable in verb acquisition in children.

The second finding—that associations with a specific region of the body may be a better predictor of whether a verb is learned early than the concreteness or abstractness of the verb—is quite challenging too. The challenge of reframing our thinking patterns to incorporate embodiment is quite daunting because, if we believe Heidegger cited in Dourish (2001), we treat our body as a "transparent equipment", that is, our body is always here with us, but we only notice it when something goes wrong. Interestingly, the idea at the origin of the phenomenological revolution in thinking that Husserl brought about was concerned with how to bring back the body to mathematics (Dourish, 2001)! All proportions kept, we propose to bring the construct of embodiment and its operationalization by the correlation with strength in associations to a main body region to a literature that has considered so far abstractness and concreteness, operationalized respectively by frequency and imageability, as the two main correlations driving word acquisition in general and verb acquisition in particular.

When we consider the arguments on abstraction and concreteness in the literature, we are left with some unanswered questions and we propose that the results presented here can potentially answer those particular questions. Basically, on one hand, the argument on the side of abstraction is that a set of highly frequent and semantically general verbs, light verbs, (such as *do, make, put, get, have, take, go, give, bring*, etc.) are thought to help children in acquiring verbs' relational meanings and promote the learning of argument structures (for a review, see Theakston et al., 2004) because (1) they are early-learned (Clark, 1978); (2) they are very frequent and thus highly salient (Clark, 1978); (3) they are associated with the syntactic pattern in which they are most frequently used (Goldberg et al., 2004); and (4) they consist of relational structures that reflect primitive and innate semantic elements (Pinker, 1989). However, although these abstract verbs are particularly early, particularly frequent and semantically general, some other verbs are also particularly early and particularly frequent and are not abstract at all, such as *eat, kiss, drink, bite, sit, walk, watch, hug*, which are the eight first verbs learned in the MCDI list together with one abstract verb: *go* (Fenson et al., 1994). Our results indicate that those verbs are learned significantly earlier than the eight light verbs, a result that semantic generality cannot explain. So the need for another variable is felt. It is also felt, because, although frequency can explain the difference in acquisition between early-learned abstract verbs and late-learned abstract verbs and can explain why infrequent concrete verbs are acquired later, it cannot easily explain why among the very low frequency verbs some are acquired before others, a result of the present analysis (I-B and I-C).

Let's consider the other argument, or concreteness and imageability. Researchers have proposed that highly imageable verbs are learned earlier than less imageable verbs (imageability hypothesis, Maguire et al., 2008). Supporting this idea, McDonough, Song, Hirsh-Pasek, Golinkoff, & Lannon (2011), correlating adult imageability ratings (taken from Masterson & Druks, 1998) with the MacArthur-Bates CDI age of acquisition English data (Fenson et al., 1994) reported a significant relationship between age of acquisition reported by parents and imageability for 44 English verbs, such that between 14 and 30 months, more imageable verbs were acquired earlier than less imageable verbs. They also found that imageability contributed to the prediction of age of acquisition beyond form class, for an additional 11% of the variance, suggesting that imageability might be a driving factor in predicting age of acquisition in addition to frequency in the input. These results, using imageability *alone,* can potentially explain why highly imageable verbs such as *eat, kiss, drink, bite, sit, walk, watch, hug*, are learned before highly frequent non imageable verbs (all the abstract verbs: light and non-light verbs). However they need frequency, to explain why some concrete verbs are learned before some other concrete with the same degree of imageability. Now, if we keep frequency and imageability constant, they cannot explain why some concrete verbs are learned earlier than some abstract verbs or some abstract verbs are learned earlier than some concrete verbs. Further, adult's rating of imageability may not correspond to children's ratings of imageability. Typically, *look* is considered a low-imageable verb in both Masterson and Druks' and Cortese and Fugget's reported lists of judgments, whereas we could certainly argue that it is much more concrete for a child as the tenants of the perspective on restricted word use have claimed (Akhtar & Tomasello, 1997; Hart & Risley, 1995; Tomasello, 2003). Recent results by Maouene et al., 2011, support his claim, and indicate that some verbs start more concrete than generally expected if we use verb-object co-occurrences in CHILDES (parent and children speech collapsed) as an operationalized criterion of the distinction between light/ heavy verbs. For example, *push* co-occurs with *buttons* 84% of the time in 36 corpora of CHILDES, and starts heavier whereas in adult judgments, it is more of a light verb. Finally, increasing the number of verbs examined, from 44 (McDonough et al., 2011) to 90 (Cortese and Fugget, 2004), did not allow us to replicate the results that overall high-imageable verbs are learned significantly earlier than low-imageable verbs. In that regard, we could argue then that the set of constraints underlying the meaning of verbs, imposed by the interaction between our action and our body morphology in parts and captured by adult associations, constitutes a more stable set of constraints than the constraints underlying imageability or lightness and heaviness (number of object type associates) because adult experiences are more influenced by abstraction than young children's.

In conclusion, we propose that these data provide a first step—and a pathway—to understanding how the body we have, and particularly its parts, may help children understand the relational meaning of early verbs, together with correlations with abstract linguistic experiences and other concrete world experiences. The current research helps us understand whether different kinds of verbs are learned in different ways, provides different lessons about early verb semantics, and sheds new light on the role of embodiment in concrete and abstract verb meaning development.

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Appendix

*The eight different measures used to analyze a hundred concrete and abstract verbs and their relation to percentages of agreement on a main body region. *t means transitive and i means intransitive.*

Verbs	Body Regions	Frequencies Childes 12-23 mo.	AoA MCDI	image ratings	Object types rescaled	% body regions rescaled	index	Distance in BR to index
bite t*	mouth	264	21	5.2	3.28	6.86	5.11	1.75
blow t	mouth	140	23	4.2	2.88	5.6	4.23	1.37
break t	hand	83	23	4.5	4.02	3.78	4.1	-0.32
bring t	hand	150	25	2.6	4.47	6.86	4.64	2.22
build t	hand	100	27	3.8	2.38	6.44	4.21	2.23
bump i	head	315	25	4.9	3.57	2.52	3.67	-1.14
buy t	hand	154	27	3.6	2.63	6.02	4.08	1.94
catch t	arm	331	24	4.4	1.49	6.86	4.25	2.61
chase t	leg	100	30	4.4	3.62	6.86	4.96	1.9
clap i	hand	53	23	5.6	1.54	7	4.71	2.29
clean t	arm	522	23	4.5	3.48	6.16	4.71	1.45
climb i	arm	177	25	5.4	0.94	3.78	3.37	0.41
close t	hand	1042	25	3.7	1.99	4.9	3.53	1.37
cook t	hand	87	23	5.4	2.63	6.44	4.82	1.62
cry i	eye	217	22	5.3	1.89	6.86	4.68	2.18
cut t	hand	419	26	5.1	2.33	6.02	4.49	1.54
dance i	leg	174	22	5.6	3.82	6.44	5.29	1.15
draw t	hand	660	25	5	2.13	6.86	4.67	2.19
drink t	mouth	811	21	5.7	1.59	5.74	4.34	1.4
drive t	hand	177	23	5.3	1.09	4.62	3.67	0.95
drop t	hand	264	26	4.3	3.77	6.16	4.75	1.42
dry t	hand	137	27	3.8	3.23	4.62	3.88	0.74
dump t	hand	207	30	4.7	2.18	4.62	3.84	0.79
eat t	mouth	1521	19	4.8	2.04	6.44	4.43	2.02
fall i	leg	848	22	4.8	1.99	3.5	3.43	0.07
feed t	hand	77	26	4.4	2.53	4.2	3.71	0.49
find t	eye	848	25	2.5	4.82	6.16	4.49	1.67

fit i	whole body	492	29	3.1	3.43	1.82	2.78	-0.96
fix t	hand	750	29	3.2	3.48	6.16	4.28	1.88
get t	hand	2701	23	1.7	3.72	5.18	3.54	1.65
give t	hand	606	22	2.8	2.63	6.3	3.91	2.39
go i	leg	5457	19	2.2	3.87	6.58	4.22	2.36
hate t	mind	0	30	3	6.4	2.38	3.93	-1.55
have t	hand	1890	26	1.9	4.72	5.18	3.93	1.25
hear t	ear	13	26	3.3	2.33	7	4.21	2.79
help t	hand	693	23	2.8	4.22	5.6	4.21	1.39
hide t	eye	90	25	3.7	3.82	2.8	3.44	-0.64
hit t	hand	67	23	4.4	2.18	5.74	4.11	1.63
hold t	arm	298	23	4	3.67	6.86	4.85	2.02
hug t	arm	167	21	5.9	2.18	6.72	4.94	1.79
jump i	leg	573	26	4.8	3.38	7	5.06	1.94
kick t	leg	197	23	5.1	1.19	6.72	4.34	2.38
kiss t	mouth	358	23	6.1	1.94	6.86	4.97	1.9
knock t	hand	124	21	4.9	0.99	5.46	3.79	1.68
lick t	mouth	30	25	5.3	2.63	6.72	4.88	1.84
like t	head	1317	26	2.7	3.87	3.36	3.31	0.05
look i	eye	2933	27	3.9	2.98	6.86	4.58	2.28
love i	heart	144	23	4	3.92	3.78	3.9	-0.12
make t	hand	838	23	2.8	4.32	6.58	4.57	2.02
paint t	hand	311	26	6.3	2.38	5.88	4.86	1.03
pick t	hand	298	29	3.8	4.72	5.18	4.57	0.62
play i	hand	1880	23	4.5	3.18	2.38	3.35	-0.97
pull t	hand	455	26	4.1	2.68	6.3	4.36	1.94
push t	hand	737	24	4.1	3.92	6.16	4.73	1.43
put t	hand	2903	25	2.2	4.57	6.44	4.4	2.04
ride i	leg	301	22	4.6	1.29	4.48	3.46	1.02
rip t	hand	0	30	4.7	2.83	6.02	4.52	1.5
run i	leg	174	23	4.6	3.38	6.58	4.85	1.73
say t	mouth	449	27	2.8	2.38	6.72	3.97	2.75
see t	eye	3121	21	3	3.57	7	4.53	2.48

shake t	hand	67	29	4.4	3.23	4.76	4.13	0.63
share t	hand	13	27	3.2	3.97	5.6	4.26	1.34
show t	hand	127	27	4	4.72	3.92	4.21	-0.29
sing t	mouth	164	25	4.9	1.34	6.02	4.09	1.93
sit i	leg	1884	19	4.7	1.14	6.86	4.23	2.63
skate i	leg	0	30	5.9	2.13	6.72	4.92	1.8
sleep i	eye	439	22	5.5	1.19	3.36	3.35	0.01
smile i	mouth	164	27	6.5	1.94	6.58	5.01	1.57
spill t	hand	53	26	4.2	2.04	6.16	4.13	2.03
splash t	hand	73	26	5.1	0.94	5.6	3.88	1.72
stand i	leg	137	26	5	3.33	7	5.11	1.89
stop t	leg	258	24	4.5	0.94	4.62	3.36	1.27
sweep t	hand	67	27	5	1.34	6.02	4.12	1.9
swim i	hand	73	23	5.6	1.69	5.32	4.2	1.12
swing t	leg	395	22	5.8	1.29	3.92	3.67	0.25
take t	hand	1334	27	2.8	7	6.86	5.55	1.31
talk i	mouth	305	26	4.7	2.23	6.72	4.55	2.17
taste t	mouth	90	29	4	2.28	7	4.43	2.57
think t	mind	301	30	2.6	2.53	2.8	2.64	-0.16
throw t	hand	268	23	4.3	1.59	6.72	4.20	2.52
touch t	hand	150	26	4.2	3.67	6.72	4.86	1.86
wait i	leg	110	26	2.6	3.08	3.5	3.06	0.44
wake t	eye	201	27	3.4	2.23	4.2	3.28	0.92
walk i	leg	368	21	5.2	2.18	6.86	4.75	2.11
wash t	hand	358	22	5.1	1.89	6.16	4.38	1.78
watch t	eye	311	25	5.9	2.04	6.3	4.75	1.55
wipe t	hand	107	25	5	2.88	4.62	4.17	0.45
wish t	mind	26	30	3	2.63	2.94	2.86	0.08
work i	hand	211	23	3.9	4.52	4.62	4.35	0.27
write t	hand	479	27	4.8	1.44	6.58	4.27	2.31