Prior studies suggest that language users perform motoric simulations when construing action sentences, and that verbs and constructions each contribute to simulation-based representation (Glenberg & Kaschak, 2002; Richardson et al., 2003; Bergen et al., 2007; Bergen & Wheeler, 2010). This raises the possibility that motorically grounded verb and construction meanings can interact during sentence understanding. In this experiment, we use the action-sentence compatibility effect methodology to investigate how a verb’s lexical-class membership, constructional context, and constructional bias modulate motor simulation effects. Stimuli represent two classes of transfer verbs and two constructions that encode transfer events, Ditransitive and Oblique Goal (Goldberg, 1995). Findings reveal two kinds of verb-construction interactions. First, verbs in their preferred construction generate stronger simulation effects overall than those in their dispreferred construction. Second, verbs that entail change of possession generate strong motor-simulation effects irrespective of constructional context, while those entailing causation of motion exert such effects only when enriched up to change-of-possession verbs in the semantically mismatched Ditransitive context. We conclude that simulation effects are not isolable to either verbs or constructions but instead arise from the interplay of verb and construction meaning.

**Keywords:** simulation semantics, motor simulation, action-sentence compatibility effect, lexical class, construction grammar, constructional meaning, verb complementation bias, verb frequency, dative opposition, dative alternation, transfer verbs, concord, English

**Introduction**

What do we, as language users, know about verbs? An emerging consensus is that verbs have rich, variegated representations: we know something about a verb’s usage history, we know something about a verb’s semantic neighbors and the idealized scene that it encapsulates (Fillmore et al., 2004), and we know something about a verb’s combinatoric potential—the syntactic patterns with which it combines (Gahl & Garnsey, 2006; Goldberg, 2006). Usage frequency, syntactic behavior, and lexical class are cornerstones of lexical description efforts (Bybee 2001, 2010; Goldberg, 1995, 2006; Levin, 1993), but they have typically been overlooked in psycholinguistic experimentation, particularly within simulation semantics (see, e.g., Barsalou, 1999; Glenberg & Kaschak, 2002; Richardson et al., 2003). In simulation semantics experiments, stimuli are typically generated via a norming study in which a group of participants makes semantic judgments about a series of words or phrases, e.g., *Does this verb convey manual motion toward the body, away from the body, or neither?* (Bergen & Wheeler, 2010). Semantic analysis is by consensus: those words or phrases which are most widely viewed as having a specific
target meaning are then used in the larger study. This practice creates *ad hoc* verb classes that may or may not align with lexical classes used in linguistic descriptions. It also isolates each verb from its usage history, its contexts of occurrence and its semantic neighbors.

In this experiment, we demonstrate that semantic and syntactic affinities of verb lexemes significantly modulate motor simulation results. Specifically, we show that independently motivated lexical classes interact with the two constructions participating in the English dative opposition (the Ditransitive construction and the Oblique Goal construction), with the result that in some situations, simulation effects are driven by lexical class semantics (irrespective of the construction being presented to participants), while in other situations, constructional semantics (and not lexical class semantics) appear to be driving the simulation effects that are observed. Furthermore, we demonstrate that the constructional biases of those verbs that participate in the dative alternation significantly predict the strength of simulation effects observed: verbs appearing in a preferred construction generate stronger motor facilitation and interference effects than verbs appearing in a dispreferred construction.

From these findings we draw several conclusions. Chief among them is that lexical simulation effects are modulated by lexical-class membership and usage frequency. We also conclude that lexical and constructional meanings have distinct but interacting effects on simulation. In addition, we validate Barsalou’s (1999) contention that “connections [that are] processed repeatedly become stronger” (p. 591): we find that those predications which are more entrenched (i.e., those instances in which a verb appears in its ‘preferred’ construction) generate stronger simulation effects than those predications which are less entrenched. Finally, we suggest that these findings address what Zwaan (2014) terms the ‘secondary scaling problem’ of simulation-based theories of representation: such theories cannot account for abstract (i.e., non-grounded) representations. We demonstrate that abstract forms of semantic representation (in particular, lexical class affiliation and construction meaning) can be linked to differences in measured motor simulation effects as members of higher-order (i.e., two-way and three-way) statistical interactions.

Ultimately, we suggest that two different kinds of concord (or ‘match’) conditions matter when we attempt to determine whether meaning construction will involve mental simulation. First, we recognize a gradient notion of concord, *frequency-based concord*: a verb appearing in the syntactic frame in which it most typically appears. A simple example is a highly transitive verb like *kick* appearing in an active voice sentence as opposed to a passive one (Gahl et al., 2003). Second, we recognize a categorical notion of concord, *lexical-semantic concord*: a match between the set of semantic roles assigned by the verb and that assigned by the construction. For example, the verb *put* matches the argument structure of the Caused Motion construction in sentences like *She put the glass on the counter* but the bivalent verb *swim* does not, and must be augmented up to a trivalent verb of caused motion in order to serve in this frame, as in, e.g., *The kids swam the logs upstream* (Goldberg 1995, Rappaport Hovav & Levin, 1998). Particularly relevant for our purposes are verb-construction interactions involving the two trivalent constructions targeted by this study: the ‘double object’ construction, as in *She gave me a compass*, and the ‘to-dative’ construction, as in *She gave gifts to her friends*. The verb *give* matches both of these syntactic contexts: it has three semantic roles (agent, theme and recipient), each of which instantiates a role of the construction. To illustrate, let us focus on the recipient role of the verb, which can be encoded in two different ways: as direct object (in the ‘double object’
construction) and as preposition phrase (in the ‘to-dative’ construction). The recipient argument of the verb give is identical to the recipient argument of the ‘double object’ construction, while it is a subtype of the ‘to-dative’ construction’s role goal (we view a recipient as a goal that happens to be a volitional human). Let us contrast this situation with that of the trivalent verb kick, as in She kicked the ball to the step. The verb kick matches only the ‘to-dative’: its three semantic roles (agent, theme, goal) map to the respective roles of the ‘to-dative’ construction. When it combines with the ‘double object’ construction, however, the verb kick must adapt to the context: its goal argument must be construed as a recipient. Note that the sentence ??She kicked the step the ball is acceptable only insofar as the step is interpreted as a potential possessor of the ball. In such cases we say that that the verb kick has been enriched up to a ‘change of ownership’ verb. We will suggest that such ‘constructional override’ effects can strengthen the simulation effects that the verb would trigger outside of the relevant context.

In the following section, we discuss the theoretical and methodological foundations of this study. Next, we enumerate the major predictions of this study, after which we describe the methods used in this study. Subsequently, we report the results of the study, followed by an extended discussion. Lastly, we offer concluding remarks.

**Theoretical and Methodological Background**

In this section, we discuss both our approach to verb-construction interaction and the method used to examine effects of constructional context. In the first subsection, we describe the constructional opposition that we will investigate here (the English dative opposition), verbal constructional bias, and Rappaport-Hovav and Levin’s (2008) lexical classes. Following that, we discuss the motor simulation methodology to be used in this experiment, and how this particular instantiation of the paradigm relates to prior art.

**The Dative Opposition, Verb Classes, and Syntactic Preference**

A dative ‘alternation’ is posited for English based on the observation that speakers can use either of two distinct syntactic patterns to express the semantic roles assigned by verbs of transfer like give, send, and mail. There are three such roles: agent, theme, and recipient. We will refer to the two options for syntactic encoding as the ditransitive construction (DC) and the oblique goal construction (OGC). In the active voice, the DC links agent to subject, recipient to object and theme to a ‘secondary’ object (referred to by Fillmore and Kay (1995) as a nominal oblique argument). The following sentence exemplifies this pattern:

(1) Lisa gave Pongo the treat.

In the active-voice version of the OGC, agent again appears as subject, but the theme argument appears as object and the recipient as an oblique (prepositionally marked) argument:

(2) Lisa gave the treat to Pongo.

The DC and OGC are often described as participating in the English dative ‘alternation’ (see, e.g., Pinker, 1989). A typical implementation of this idea views the DC as the output
of either a lexical rule or syntactic transformation whose input is the OGC pattern. For example, Gropen et al. (1989) propose a semantically based lexical rule whereby the componential semantic representation of an input transfer verb is converted from ‘x cause y to go to z’ to ‘x cause z to have y’, ensuring, via general linking principles, that in the former case the theme argument is linked to the grammatical function direct object (thus yielding oblique-goal syntax), and in the latter case that the recipient is linked to direct object (thus yielding ditransitive syntax). Goldberg (1995) suggests that this view is untenable, in part because the necessary input forms are lacking in some cases. She observes:

[A]pproaches that rely on transformations … posit an often unwarranted asymmetry between two constructions that are thought to be related. In the case of the ditransitive, *He gave the book to her* is usually supposed to be more basic than *He gave her the book* … A typical reason given is that the verbs which allow ditransitives are a proper subset of those that allow prepositional paraphrases. However, this is not actually so: *refuse* and *deny* do not have paraphrases with *to* or *for*, and neither do many metaphorical expressions. (Goldberg 1995: 106)

Thus, we see the following grammaticality contrasts, in which the ditransitive pattern is acceptable while putative ‘input,’ the oblique-goal pattern, is not:

(3) The manager denied the employee a raise.
(4) *The manager denied a raise to the employee.
(5) The noise gave my mother a headache.
(6) *The noise gave a headache to my mother.

In an alternative implementation of the lexical rule idea, neither pattern is derived from the other; rather, we assume that verbs within a given lexical class (say, transfer verbs) are underspecified with regard to the syntactic expression of their semantic roles (Bresnan, 1994) and thus subject to competing linking principles (among them, the default principle that requires a theme argument to link to direct object). Both the transformational model and the underspecification models share an assumption that Michaelis and Ruppenhofer (2001) refer to as conservation of thematic structure. According to this assumption, linking rules change the syntactic expression of the verb’s argument roles, but do not add or subtract semantic participant roles from those assigned by the verb. The conservation assumption cannot be maintained in the case of the dative alternation, as shown by ditransitive examples like (7-8):

(7) Aunt Ruby knitted her a pillow.
(8) Fred tossed me the ball.

Neither the creation verb *knit* nor the ballistic-motion verb *toss* can be said to select for a recipient role on the basis of their lexical meanings, and yet each appears with a recipient argument in (7-8). Where does this recipient argument come from if not from verb meaning? Goldberg (1995) argues that it comes from the DC, which she considers to be a conventionalized pairing of form (the skeletal pattern V-NP-NP) with a coarse-grained
event structure, 'X causes Y to have Z'. Such constructions, which Goldberg refers to as *argument-structure constructions*, have their own semantic-role sets, which can differ from the role sets assigned by verbs. In such cases, as in (7-8), the construction 'overwrites' the verb's array of semantics roles so that it matches that of the construction. In sum, syntactic patterns like the DC do not merely regulate the syntactic expression of arguments; they are meaningful patterns that can make semantic contributions to the clause that is not traceable to its main verb. Thus, when we consider the dative alternation, it should be borne in mind that we are discussing a choice between nearly synonymous constructions, rather than, say, a transformational relationship or lexical rule.

What factors drive the language user to select one construction over the other? This question has been widely debated. On one side of this debate, many scholars posit that the choice is driven by discourse-pragmatic factors (see, e.g., Erteschik-Shir, 1979; Givón, 1984; Thompson, 1995; Wasow, 2002; Ruppenhofer, 2004). On the other side of this debate are scholars who propose that lexical-semantic entailments, often represented via decomposed semantic structure, condition the use of one form over the other (see, e.g., Mazurkewich and White, 1980; Pinker, 1989; Jackendoff, 1990; Groesfema, 2001; Levin, 2008; and Rappaport Hovav and Levin, 2008). Because a thorough examination of the merits of both sides of this debate would take us relatively far afield, we will simply state that a hybrid model is adopted here, in which a combination of discourse-pragmatic factors affect syntactic distributions that are largely determined by lexical semantics (see Rappaport-Hovav and Levin (2008) for further discussion), and constructional meaning serves to enrich (or alter) the semantic representations of verbs.

For our purposes here, a crucial fact about the English dative alternation is that the various verbs that participate in it almost always ‘prefer’ one alternant over the other. For example, in a 2005 corpus study, Mukherjee found that the ratio of DC instantiations to OGC instantiations for the verb *show* was 3.58, whereas for *send*, this same ratio was 0.97 (see Ruppenhofer (2004) for similar quantitative measures). In this study, this same ratio was calculated via corpus study for a range of verbs using the British National Corpus (a 100-million-word corpus of spoken and written British English distributed by Oxford University Computing Services on behalf of the BNC Consortium); these ratios will be provided below.

As noted above, verbal constructional preference is viewed in this experiment as a form of frequency, and expressing this preference as a ratio (rather than as a combination of raw scores) taps into a different form of frequency from that which raw scores would represent. For example, a verb with a ratio of 2:1 may be found in the corpus in a DC context a total number of 2 times or 200,000 times. What concerns us here, however, is not how often a verb is used, but, rather, where it is used—what construction speakers are more likely to pick in order to describe a transfer event. Thus, a verb that has a ratio of 2:1 is encountered in the DC twice as often as in the OGC, while a different verb with a ratio of 1:2 is used twice as often in the OGC as in the DC.

Previous research in linguistic cognition has demonstrated that verbal constructional bias is a cue that speakers use to organize linguistic experience. Verbal syntactic preference is, for example, a cornerstone of interactive models of sentence comprehension and production. Garnsey et al. (1997) show that a verb’s syntactic preference (in particular, where it is more apt to take a direct object or a clausal complement) influences the resolution of syntactic ambiguity in temporarily ambiguous
structures in which clausal and nominal completions are equally sensible (e.g., *The senator acknowledged the reporter...*). Similarly, using a plausibility judgment task, Gahl et al. (2003) show that lexical bias affects the comprehension difficulties experienced by aphasic subjects presented with undergoer-subject sentences. They find that sentences whose structure matches the lexical bias of the main verb are significantly easier to comprehend than sentences in which structure and lexical bias do not match. Additionally, Gahl & Garnsey (2004) find that verbal syntactic bias affects the syntactic structures that speakers anticipate hearing, thereby affecting certain aspects of pronunciation. Verbal syntactic bias also underpins functionally oriented models of language acquisition. For example, Goldberg (2006) reports prior research in which certain verbs were found to be highly predictive of certain syntactic environments in child-directed speech:

> [W]e found a strong tendency for there to be one verb occurring with very high frequency in comparison to other verbs used in each of the constructions analyzed. That is, the use of a particular construction is typically dominated by the use of that construction with one particular verb. For example, *go* accounts for a full 39 per cent of the uses of the intransitive motion construction in the speech of mothers addressing twenty-eight-month-olds in the Bates et al. (1988) corpus. (Goldberg 2006: 75)

Goldberg concludes that the predictive power of verb bias is the mechanism by which constructional meaning is extrapolated. For example, if in acquiring the DC, a child is predominantly exposed to instances of this construction wherein *give* is its main verb, then he or she will build an association between that particular syntactic configuration and the type of transfer entailed by the verb *give*. After the child learns to generalize beyond that most prototypical verb-construction pairing, the residual meaning of that verb remains, with the result that even if a verb like *head* is used in the DC (as in *I headed him the soccer ball*), a change of possession frame will still be invoked.

It is hypothesized here that verbal constructional bias should significantly predict simulation effects. Specifically, we posit that verbs of transfer appearing in their preferred construction will generate stronger motor simulation effects. Why should there be such an effect? Is this effect attributable to semantic concord? Our answer is no. Verb biases (like the complementation biases reported by Garnsey et al. 1997) may have many sources—including historical accident—although they may often be ascribable to semantic factors like lexical-semantic concord. Thus, because the verb *give* entails transfer of possession, we might predict it to favor the DC, and because the verb *send* denotes caused motion (but doesn’t entail successful transfer), we might predict it to favor the OGC. These predictions are borne out by the corpus analysis: *give* has a DC:OGC ratio of 2.98/1 and *send* has a DC:OGC ratio of 0.47/1. At the same time, however, the effect of bias must be distinguished from that of semantic concord. Of the verbs used in this study, there are several in the CP class that heavily favor the OGC (*pass, hand, and lend*), and in the CM class, there are verbs that only slightly favor the OGC over the DC (*slide and throw*). In other words, while there may be some degree of overlap between lexical-semantic concord and frequency-based concord (i.e., constructional bias), the data suggest that they are distinct. We assume here that frequency-based concord has the effect it does because the representations associated with high-frequency linguistic collocations are more entrenched, and thus have stronger motor representations. According to this assumption,
the verb *show*, since it tends strongly to occur in the DC: *show* is a more predictable part of a DC predication than an OGC predication. A low predictability verb simply adds noise to a signal that might otherwise have been interpreted as a pattern of motor-simulation-based activation. Put differently, the less interpretive effort must be directed toward combining verb meaning and construction meaning, the more interpretive resources are available for simulation.

For Rappaport Hovav & Levin (2008), a verb’s constructional preference is determined by, among other things, its lexical class. They postulate that two major classes of verbs participate in the English dative alternation: (1) Caused Possession (CP) verbs, like *give* and *sell*, and (2) Caused Motion (CM) verbs like *kick* and *throw*. When CP verbs are used in the DC or OGC, they entail causation of possession. This class comprises verbs expressing physical change of possession like *give* and *hand*, verbs of future having like *bequeath* and *promise* and verbs of communication like *tell* and *ask*. By contrast, the CP class (which includes, e.g., verbs of sending, verbs of instantaneous causation of ballistic motion, verbs of instrument of communication, etc.), expresses transfer of possession in the DC, but expresses causation of motion in the OGC. Thus, we see a semantic asymmetry between the two classes of verbs. This asymmetry is illustrated by the following contrast pairs:

(9) #Anna gave Debbie the present, but she never received it.
(10) #Anna gave the present to Debbie, but she never received it.

(11) #Anna sent Debbie the present, but it never got there.
(12) Anna sent the present to Debbie, but it never got there.

Rappaport-Hovav & Levin explain the pattern in (9-12) in the following way. If transfer of possession is entailed either by a predication’s construction or by its main verb (or by both), then it is incoherent to deny that transfer of possession occurred. Thus, both (9) and (10) are internally contradictory, either because both construction and the verb entail transfer of possession (9) or because the verb alone entails it (10) or because the construction alone entails it (11). Conversely, if change of possession is not entailed by either a predication’s construction or its main verb, then stating that a transfer of possession did not occur is perfectly felicitous, as in (12).

Given all of the above, we expect that CP verbs should produce identical simulation effects in both DC and OGC, as their change-of-possession entailment is constant across both types. By contrast, CM verbs are presumed to entail a change of possession only in a DC predication, merely entailing a change of location in the OGC.

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1 It should be noted that Rappaport Hovav and Levin refer to the above classes of verbs as “dative verbs having only a caused possession meaning” and “dative verbs having both caused motion and possession meanings,” as the latter class is observed to have a caused motion meaning when appearing in the OGC and a caused possession reading when appearing in the DC. These labels are here replaced with the labels ‘caused possession verbs’ (CP verbs) and ‘caused motion verbs’ (CM verbs) not only for the sake of brevity but also because we believe it is misleading to imply that verbs in the CM class have both a caused-motion and a caused-possession entailment. Verbs like *throw*, which do not inherently select for a recipient argument, gain a caused-possession entailment only by virtue of combining with the DC construction; thus, the caused-possession entailment is contributed by the construction and not by the verb.
Therefore, we expect to see simulation-based differences between the two constructions when the predication contains a CM verb.

Why would a predication denoting an event of transfer of possession generate different motor simulation effects from one denoting an event of change of location? We expect to observe simulation-based differences between scenes of caused motion and scenes of caused possession because only the latter type of scene involves human interaction, and in particular an animate recipient (see, e.g., Goldberg, 1995, 2006; Rappaport Hovav & Levin, 2008). In depicting a scene of caused motion, one could speak of kicking a football to the fifty-yard line, but in this case the fifty-yard line is a goal rather than a recipient: it does not come to possess the football as a result of the kick. While both transfer of possession and causation of motion scenes could in principle evoke mental simulation, we presume that the former are more likely to be mentally reenacted, because an act of transferring possession requires coordinated action. A causation-of-motion event involves a relatively uncontrolled trajectory (e.g., we cannot predict with certainty where a ball once kicked will come to rest). A transfer-of-possession event, by contrast, is controlled by humans at either end of the theme’s path: the donor releases the possession as the recipient accepts it. The special significance that language users accord to such transfer events is reflected in the fact that the DC is acquired earlier by children than the OCG, probably as a result of the DC’s prevalence in the adult input (Campbell & Tomasello 2001).

Motor Simulation Effects and Methodologies

The methodology used in this study (henceforth referred to as the motor facilitation and interference paradigm) was initially utilized in a landmark study by Glenberg & Kaschak (2002). Numerous subsequent studies have used this methodology (or variations thereof) and achieved significant but varying results (for a general review, see, e.g., Fischer & Zwaan, 2008; Anderson & Spivey, 2009). As in other simulation semantics experimental methodologies, at the core of the paradigm lies the idea that representation utilizes some of the same resources as action execution and/or perception (Barsalou, 1999), and, therefore, that activating certain linguistic representations should, in some form, affect motor execution. This notion finds support in various neuroimaging studies (see, e.g., Pulvermüller, 1999, 2001; Hauk et al., 2004), which have demonstrated that the act of reading words that deal with motor actions and concepts activates the motor cortex, and that the act of reading words dealing with visual scenes similarly activates the visual cortex. Hauk and colleagues (2004) even showed that verbs denoting physical actions using different body parts (i.e., hand, leg, face) activated the specific sub-regions of the motor cortex responsible for controlling those body parts.

Like the neuroimaging methodologies used in the aforementioned studies, the motor facilitation and interference paradigm detects language-induced motor-cortical activation. The extent of this activation is gauged via arm movement time in a button-press task (to be discussed in greater detail below).

In the motor facilitation and interference paradigm, participants are presented with some form of linguistic stimulus (either written or auditory) and then given a binary response choice, one of which is physically congruent in some way with the linguistic stimulus, and the other which is physically incongruent with the linguistic stimulus. In the majority of motor facilitation/interference studies, this is done through a rig consisting of...
three buttons (often a keyboard rotated ninety degrees from its typical orientation on the transverse (i.e., horizontal) plane). This is illustrated in Figure 1.

**Fig. 1:** A bird’s-eye view diagram of the motor facilitation/interference setup used in the study.

In the three-button rig shown in Figure 1, we see a central yellow button that is used to display stimulus sentences on the computer monitor. Stimulus sentences are displayed only as long as the yellow button is held down, and upon its release, these sentences disappear. After reading a stimulus sentence, participants may then choose either the green or red button. Crucially, these buttons are oriented such that pressing one button requires arm movement away from the body while pressing the other button requires arm movement toward the body. Thus, under the right experimental conditions, investigators may gather both motion-congruent and motion-incongruent responses by providing stimulus sentences that are compatible or incompatible with the location of the green button. For instance, the sentence *You are throwing the ball* is congruent with an away button press but incongruent with a toward button press. Conversely, the sentence *You are touching your nose* is congruent with a toward button press but incongruent with an away press.

The motor simulation methodology used in this experiment differs slightly from previous approaches (see, e.g., Glenberg & Kaschak, 2002; Bergen & Wheeler, 2010) in that all of its critical trials involve a single direction of motion; previous studies have implemented both toward and away variants. Because this study is concerned solely with verb and construction classes that convey removal from a person (the subject argument), only predications with main verbs that denote acts of transfer away from the body (with verbs like *throw, send* and *hand*) were implemented; all such predications featured second-person subjects. More information on this design is provided in the Methods section below.

**Predictions**
We offer two major predictions regarding the effects of both frequency-based and lexical-semantic concord in this experiment:

**Prediction One (effects of frequency-based concord):** Each verb’s constructional bias will interact with the construction in which it appears and the semantic congruity condition in which it appears with the result that, for example, a verb that ‘prefers’ to appear in one construction (e.g., the OGC) will generate stronger facilitation or interference effects in that construction than in its dispreferred counterpart (e.g., the DC). We expect this bias effect because, as discussed above, representations that are more heavily entrenched should yield strengthened simulation effects.

**Prediction Two (effects of lexical-semantic concord):** There will be no difference in motor simulation effects between CP verbs appearing in the DC and CP verbs appearing in the OGC. As CP verbs (e.g., give, lend) entail successful receipt in either syntactic environment, it is expected that predications containing CP verbs will yield similar simulation effects in the two constructional conditions. By contrast, for predications containing CM verbs like toss and send, we expect to observe motor simulation differences between the DC and the OGC contexts for the following reason: in the DC context, CM verbs entail transfer of possession via contextual enrichment, while in the OGC context, CM verbs do not. In other words, CM verbs need the ‘boost’ that the DC provides: CM verbs do not assign a recipient role unless the DC imposes this construal on the verb’s goal argument. It is only when the goal argument is interpreted as a recipient that a sentence depicts a change of ownership. Recall from the foregoing discussion that we presume caused-possession predications—whether these feature a CP verb or Ditransitive form or both—to have more readily simulated content, because they depict coordinated acts of transfer. The caused-motion scenario does not intrinsically involve human interaction; therefore, the motor-simulation effects evoked by CM verbs in the OCG context are expected to be weaker than those evoked by CP verbs in either constructional context.

These predictions and other findings will be revisited and discussed below.

**Methods**

In the following sections, we describe the study’s participants, stimuli and design, and procedure.

**Participants**

After receiving approval of the protocol from the University of Colorado Boulder IRB, the authors recruited forty native English-speaking subjects over the age of eighteen years. Subjects participated in the experiment for either course credit or monetary compensation. Those who participated for course credit were undergraduate students enrolled in Linguistics courses at the University of Colorado Boulder. Those who participated for monetary compensation were members of the larger Boulder community.
who were recruited via flyer. All forty participants successfully completed the experiment. These participants ranged in age from 18 to 50 years of age (average = 23.32, SD = 7.25). Thirty-six participants described themselves as right-handed, two participants described themselves as left-handed, and two participants described themselves as ambidextrous. All participants had normal or corrected vision.

Participants were also asked about their linguistic backgrounds; forty participants described themselves as native English speakers. Thirty-seven of these participants described themselves as native monolinguals, while the remaining three participants were native bilingual. Of the bilingual speakers, two spoke Spanish and English, and one spoke Korean and English.

**Materials**

In this study, 56 critical stimuli were grouped with 64 non-critical stimuli to yield a total of 120 stimulus sentences (see Appendices A and B). These stimulus sentences were broken up into two blocks of 60 trials each. Critical stimuli were tagged for several different variables: Dative alternation variant used (DC or OGC), verb constructional ‘preference’ (expressed as the ratio of instances where the verb appears in the DC to instances where the verb appears in the OGC), verb class according to the taxonomy provided by Rappaport Hovav & Levin (2008) (CP or CM), sentence-to-button-press congruity (congruent or incongruent), and number of mentions of the stimulus’s main verb in the experiment (1-4). Overall, fourteen different verbs were used in the study, and each verb appeared four times (twice in the DC and twice in the OGC). Seven of these fourteen verbs were members of the CM class, while the other seven were members of CP class. These class memberships (along with each verb’s constructional ratio) are provided in Table 1 below:

**Table 1: A listing of the verb classes and constructional ‘preference’ (ratio of DC occurrences in the BNC to OGC occurrences in the BNC) of selected different dative-alternating English verbs.**

<table>
<thead>
<tr>
<th>Verb</th>
<th>Class</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fling</td>
<td>Caused Motion</td>
<td>0.813</td>
</tr>
<tr>
<td>Flip</td>
<td>Caused Motion</td>
<td>0.667</td>
</tr>
<tr>
<td>Lob</td>
<td>Caused Motion</td>
<td>0.4</td>
</tr>
<tr>
<td>Send</td>
<td>Caused Motion</td>
<td>0.472</td>
</tr>
<tr>
<td>Slide</td>
<td>Caused Motion</td>
<td>0.852</td>
</tr>
<tr>
<td>Throw</td>
<td>Caused Motion</td>
<td>0.981</td>
</tr>
<tr>
<td>Toss</td>
<td>Caused Motion</td>
<td>0.545</td>
</tr>
<tr>
<td>Give</td>
<td>Caused Possession</td>
<td>2.98</td>
</tr>
<tr>
<td>Hand</td>
<td>Caused Possession</td>
<td>0.616</td>
</tr>
<tr>
<td>Lend</td>
<td>Caused Possession</td>
<td>0.498</td>
</tr>
<tr>
<td>Loan</td>
<td>Caused Possession</td>
<td>1.353</td>
</tr>
<tr>
<td>Offer</td>
<td>Caused Possession</td>
<td>1.649</td>
</tr>
<tr>
<td>Pass</td>
<td>Caused Possession</td>
<td>0.494</td>
</tr>
<tr>
<td>Show</td>
<td>Caused Possession</td>
<td>4.135</td>
</tr>
</tbody>
</table>
It should be briefly noted that all of the critical trials featured in this study denoted some form of manual motion away from the body, while none could be readily construed as denoting some form of manual motion toward the body. This interpretation was ensured by placing a second-person subject in each sentence along with a transfer verb and a third-person recipient, as in the following:

(15) You are flinging Freddie the Frisbee.
(16) You are giving the package to Marla.

Stimulus sentences were designed with additional specifications in mind so as to maximize consistency across trials and minimize the extent to which other linguistic factors could be affecting participant responses. As stated above, every stimulus sentence presented to participants began with the second person singular pronoun you. Verbs were also presented every time in the present progressive. Each stimulus sentence’s recipient argument was also presented as a disyllabic proper name (e.g., Ernie, Sally, Lisa), and each stimulus sentence’s theme argument was presented as a definite noun phrase. Thus, all stimulus sentences occurred in one of two general forms: (1) You are <verb>ing <name> the <noun> or (2), You are <verb>ing the <noun> to <name>.

Critical trials were generated by inserting any of the verbs featured in Table 1, above, into one of the above two constructions. Each verb was paired with two different theme objects such that each verb-object pairing was seen by participants in both the ditransitive and oblique goal constructions. These verb-theme pairings were determined by selecting themes that would pair naturally with their partner verbs. Thus, fling was paired with frisbee but not basket, while offer was paired with basket but not frisbee, and so forth.

Finally, filler trials were created by simply taking verbs whose argument structure configurations were incompatible with both the ditransitive and oblique goal constructions, and plugging them into the two constructional templates mentioned above. This yielded sentences like You are snoozing Christian the whistle and You are walking the child to Harold. As the task required participants to make grammaticality judgments about the sentences they saw, these stimuli served as ungrammatical counterparts to the grammatical critical trials.

Design and Procedure

Participants were tested in one session that lasted roughly fifteen minutes from start to finish. Participants were seated at a desk with a laptop computer and response collection apparatus and asked to fill out a brief survey detailing their linguistic and cognitive background information. Following this, the main task was commenced. Instructions asked participants to decide whether or not the sentences they saw were grammatical. Following a brief block of practice trials (n = 5), any questions on the part of the participant about the experiment procedure were answered, and then participants were free to complete the experiment in self-paced fashion. Halfway through the experiment, an optional break was provided to participants.

Each individual trial of the experiment began with a blank screen. The act of holding down the central yellow button on the response collection apparatus would cause a stimulus sentence to appear onscreen. As soon as the participant released the yellow
The onscreen sentence would disappear (pressing the yellow button down again would not cause it to reappear), and participants would then press either the green button or the red button to record a judgment. After one of these response buttons had been pressed, the screen would briefly flash to let the participants know that the response had been received and that the participant had progressed to the next trial in the experiment.

This study employed a mixed design which had both within-subjects and between-subjects dependent variables. Specifically, of the variables mentioned above, all were within-subjects except for sentence-to-button press congruity. In the case of this variable, one half of the experiment participants ($n = 20$) completed the task with the target button in the sentence-congruent location (i.e., farthest away from the body), while the other half ($n = 20$) completed the task with the button in the sentence-incongruent location (i.e., closest to the body).

The main dependent variable of this study was response time—specifically, the time between participants’ releasing of the yellow button (the button used to display sentences) and the pressing of the green response button. As with other simulation-based studies in the motor facilitation and interference paradigm, variations in these response times are presumed to signal simulation-based motor interference or facilitation effects.

Crucially, however, as this experiment was driven by participants’ assessments of grammaticality, only critical sentences in which participants pressed down the green button—and were expected to press down the green button—were accepted as part of the data pool. Thus, of a total of 2,240 critical trial responses, 105 (or 4.7%) were not used.

**Results**

Responses that took less than 200 ms or more than 1,000 ms were removed from the data. Of the 2,135 trials collected in which participants hit the correct response key, zero were less than 200 ms, and 97 (4.5%) were greater than 1000 ms, leaving a total of 2,038 trials used in the statistical analysis. A mixed models analysis with crossed random effects for participant and item was performed. This analysis yielded one significant main effect, two additional main effects that approached significance, and three significant interaction terms. Each of these findings will be briefly highlighted below, and then treated more thoroughly in the Discussion section.

The significant main effect involved the number of main verb mentions in this experiment (Wald $\chi^2(1, n = 40) = 101.46, p < 0.0001$): as number of mentions increases (each verb was seen a total number of four times), reaction time decreases. This effect is illustrated in Figure 2.

**Fig. 2:** A significant effect for short-term frequency (i.e., number of main verb mentions), where participant response time decreases as number of mentions increases.
Although the above result is highly significant, it is likely a product of habituation effects rather than simulation effects, as participants become more acclimated to the experimental task (and thus complete individual trials more rapidly) as experimental trials progress.

As noted above, two additional main effects were observed to approach significance in the data. These were participant age\(^2\) \(\chi^2(1, n = 40) = 3.13, p = 0.08\) and sentence congruity (congruent versus incongruent) \(\chi^2(1, n = 40) = 2.88, p = 0.09\). The main effect for sentence congruity (button-press-is-congruent versus button-press-is-not-congruent), which approached significance, is illustrated in Figure 3.

**Fig. 3:** *Average participant response times for congruent and incongruent button press conditions.*

---

2 We observed a direct (albeit statistically insignificant) correlation between age and response time, where average response time increases with age. Such a result is most likely a product of an age-related mild slowing of reflexes, and likely not related to simulation effects.
Figure 3 shows the relationship between congruent and incongruent conditions. In particular, trials in which the button press location is congruent with sentence meaning (i.e., button is located farther away from the body) are observed to require, on average, 506 ms, while trials in which the button press location is incongruent with sentence meaning (i.e., button is located closer to the body) are observed to require, on average, 539 ms. Given that close button press filler trials were observed to require 569 ms on average, and far button press filler trials were observed to require 530 ms on average, we can cautiously portray the above results as a combination of a mild interference effect and a strong facilitation effect. Again, while this result is not statistically significant, several higher-order interaction terms contain sentence-to-button-press congruity as one of their items, and, in light of the character of those interaction terms (where some predication types generated much weaker motor simulation effects than others), the above result is not entirely surprising. This point will be discussed more thoroughly in the following section.

We now turn to the three significant interaction terms. The first is a significant two-way interaction between construction type and sentence congruity ($\chi^2(1, n = 40) = 4.29, p < 0.05$): the incongruent condition was observed to generate longer response times, while the congruent condition was observed to generate shorter response times. However, in this instance, a notable difference between the DC and the OGC was observed, where, overall, the DC was generated stronger motor simulation effects than the OGC. This distribution will be treated in the Discussion section below.

The second is a significant three-way interaction between construction type, verb constructional bias and sentence congruity ($\chi^2(1, n = 40) = 3.85, p < 0.05$). This complex and significant interaction reveals that constructional bias does indeed modulate motor simulation effects, and that verbs appearing in their ‘preferred’ construction generate stronger effects overall. This finding will therefore also be treated in detail in the following section.

The third is a significant three-way interaction in the data between construction type, sentence congruity, and lexical class ($\chi^2(1, n = 40) = 8.61, p < 0.01$). This significant interaction term reveals that Rappaport Hovav & Levin’s (2008) transfer verb classes
work in combination with the DC and OGC in order to predict motor simulation effects. This result will be explored in the Discussion section below.

**Discussion**

As briefly detailed in the Results section above, this study produced several significant results, all of which have potential ramifications for theories of simulation-based linguistic representation. As mentioned above, the data yielded a significant main effect for short-term frequency (as well as two other main effects that approached significance). This effect, however, is attributable to habituation effects; it did not significantly interact with other factors in the statistical model. In short, the significant main effect for short-term frequency tells us very little about the manner in which this type of frequency may modulate motor simulation effects. There are, however, three other significant findings that do bear on the general theory of mental simulation presupposed in this article. These will be discussed in turn below.

*Construction Type Significantly Predicts Motor Simulation Effects*

Before addressing the hypotheses given in the Predictions section above, we report a more general finding that is relevant to both of our hypotheses: a significant two-way interaction between sentence congruity and construction type. This relationship is detailed in Figure 4.

**Fig. 4**: A significant two-way interaction between construction type and sentence-to-button press congruity.

<table>
<thead>
<tr>
<th>Construction Type and Congruity (p &lt; 0.05)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Response Time (ms)</strong></td>
</tr>
<tr>
<td>DC/Congruent:</td>
</tr>
<tr>
<td>DC/Incongruent</td>
</tr>
<tr>
<td>OGC/Congruent:</td>
</tr>
<tr>
<td>OGC/Incongruent:</td>
</tr>
</tbody>
</table>

In the above, the first and second columns represent congruent and incongruent conditions (respectively) for stimulus sentences instantiating the DC. Correspondingly, the third and fourth columns represent congruent and incongruent conditions.
(respectively) for stimulus sentences instantiating the OGC. In this case, a two-way interaction is observed because the character of the relationship between the simulation results elicited by congruent and incongruent stimulus sentences changes based upon the construction seen by participants. In particular, it appears that simulation effects elicited by the DC are, on the whole, slightly stronger than those elicited by the OGC. This is readily observable in both congruent and incongruent conditions, as the average participant response time in the DC is both faster in the congruent condition and slower in the incongruent condition.

This difference in the character and magnitude of the simulation effects generated here may be a product of the semantics of the constructions used. Specifically, the DC entails transfer of possession, but the OGC does not: oblique-goal sentences may express either transfer of possession or causation of motion, depending on the entailments of the verb. When language users see an instance of the DC, they may therefore unambiguously simulate a scene in which transfer of possession occurs, whereas language users encountering the OGC may not do so.

*Frequency-Based Concord Significantly Predicts Motor Simulation Effects*

Having established that the DC and OGC significantly differ with regard to their characteristic motor facilitation and interference effects, we now turn to our first prediction, involving the effects of frequency-based concord on motor simulation: a verb will generate stronger simulation effects when appearing in its preferred construction. This prediction is confirmed by a significant three-way interaction between construction type, sentence congruity, and main verb construction ‘preference.’ This interaction is detailed in Figure 5.

*Fig. 5: A significant three-way interaction between construction type, sentence-to-button press congruity, and verbal constructional preference.*
The above figure breaks down participants’ average response times in several different ways. First, the x-axis constitutes a given verb’s ratio of DC appearances to OGC appearances. Thus, line segments left of the “1” axis mark above indicate instances of verbs that ‘prefer’ to appear in the OGC, while line segments right of the “1” axis mark indicate verbs that ‘prefer’ to appear in the DC.

When looking at the lines themselves inside Figure 6, we can see that the topmost and bottommost lines correspond to the interference and facilitation conditions (respectively) for stimulus sentences appearing in the DC. Correspondingly, the middle two lines correspond to the interference and facilitation conditions for the OGC. Thus, when looking at the lines that correspond to the DC, we can interpret the right side of these lines as representing verbs that (a) prefer to appear in the DC and (b) are, in fact, appearing in the DC (i.e., verbs that have the highest degree of frequency-based concord). On the left side of these lines, then, are the verbs which prefer to appear in the OGC but are instead being presented in the DC (i.e., verbs that have the lowest degree of frequency-based concord).

The opposite is true for the two middle lines (i.e., the lines corresponding to sentences presented in the OGC). In this case, the left side of these lines can be interpreted as representing verbs which prefer to appear in the OGC and, in fact, are appearing in that construction (and therefore have the highest degree of frequency-based concord). On the right side of these lines, by contrast, are verbs that prefer to appear in the DC, but are being shown in the OGC (and therefore have the lowest degree of frequency-based concord).

With the above in mind, we can now observe a few distinct patterns in Figure 5. First, it is immediately clear once again that the DC generates stronger motor simulation
effects than does the OGC; however, at lower ratios (i.e., in predications whose verbs favor the OGC or do not strongly favor either construction), the difference between the DC and OGC is nullified. Second, frequency-based concord is predictive of motor simulation effects. In other words, when a verb favors a particular construction in the English dative alternation and appears in that favored construction, it generates stronger motor simulation effects, on average, than when it appears in its dispreferred pattern. This is illustrated by the fact that as x-axis values increase, the distance between congruent and incongruent conditions for the DC steadily increases. Correspondingly, as x-axis values decrease, the distance between congruent and incongruent conditions for the OGC also steadily increases (albeit to a lesser extent).

**Lexical-Semantic Concord Significantly Predicts Motor Simulation Effects**

According to our second prediction, the effect of constructional context on motor simulation will differ according to whether the verb’s array of participant roles matches that of the construction. When the DC enriches a CM verb up to a CP verb, we will see enhanced simulation effects relative to the OGC context. This prediction is confirmed by a significant three-way interaction effect between construction type, sentence directional congruity and lexical class. To make sense of this interaction, we must recall Rappaport Hovav & Levin’s lexical-class-driven theory of the dative alternation, discussed in the Background section above. The authors propose that two major classes of verbs participate in the English dative alternation: verbs having only a caused possession sense regardless of constructional environment (CP verbs), and verbs having either a caused motion or a caused possession sense, depending on constructional environment (CM verbs). When a verb from either of these verb classes appears in the DC, the CP-CM distinction becomes irrelevant, as all verbs appearing in the DC necessarily entail transfer of possession. In the OGC environment, by contrast, there remains a distinction between those causative verbs that entail a change of possession and those that do not, such that lexical class is a relevant factor. Our findings support this model. We find no construction-driven differences in simulation effects observed for CP verbs, because all CP verbs have the same (transfer of ownership) meaning regardless of the construction in which they appear. At the same time, there are construction-driven differences in simulation effects observed for CM verbs, because these verbs, according to Rappaport Hovav & Levin (2008) have distinct entailments depending on the construction in which they appear: in the DC, these verbs evoke a caused possession sense, while in the OGC, these verbs evoke only a caused motion sense. Figure 6 illustrates this distribution.

**Fig. 6:** A significant three-way interaction between construction type, sentence-to-button-press congruity, and lexical class.
In Figure 6, we see eight colored columns. Columns 1-4 represent all categories of the DC, while columns 5-8 represent all categories of the OGC. Caused motion verbs are shown in columns 1, 2, 5, and 6, while caused possession verbs are shown in columns 3, 4, 7, and 8. Finally, columns 1, 3, 5, and 7 represent button-press-congruent trials, while columns 2, 4, 6, and 8 represent button-press-incongruent trials.

As discussed, we posited that CP verbs would trigger the same motor simulation effects whether appearing in the DC or the OGC. Looking at columns 3, 4, 7, and 8, we can see that CP verbs do indeed pattern virtually identically in the two syntactic contexts. In the case of CP verbs appearing in the DC, we see average response times of 505 ms in the congruent condition, and 537 ms in the incongruent condition. Similarly, these same verbs appearing in the OGC generate average response times of 504 ms in the congruent condition and 536 ms in the incongruent condition. In short, there is virtually no difference between these conditions, as predicted.

Turning to CM verbs, let us recall that these verbs should exhibit significantly different patterns in the DC versus the OGC. We expect this divergence because CM verbs are presumed to have a caused possession reading in the former construction, but a caused motion reading in the latter construction. As the caused possession scenario is presumed more likely to trigger motor simulation effects, we anticipated that motor simulation effects should be the strongest in the DC. Looking at columns 1, 2, 5, and 6, we see that this is indeed the case. Specifically, strong motor simulation effects are seen for CM verbs in the DC context, where average response times are 494 ms in the congruent condition and 545 ms in the incongruent condition. Conversely, in the OGC context, the differences between congruent and incongruent conditions are the smallest of any congruent/incongruent pair in the experiment (520 ms and 540 ms, respectively).
Our findings suggest that verb-construction conflict, rather than ‘derailing’ interpreters, provides a cue during meaning construction. By recognizing that construction meaning and verb meaning make distinct and potentially conflicting contributions to sentence meaning (Michaelis, 2004), we can make sense of an initially counterintuitive result. Although CP verbs evoke reliable motor simulation effects in both the DC and OGC contexts, CM verbs evoke, on average, even stronger simulation effects in the DC than CP verbs do. The difference between incongruent and congruent conditions for CM verbs in the DC is roughly 50 ms, while this same difference is roughly 32 ms for CP verbs in the two constructions. How can we explain this finding while preserving the claim that a scenario involving transfer of possession is more readily simulated than one involving causation of motion? The answer involves lexical-semantic concord, or the lack of it. In a predication characterized by both DC form and a CP verb, constructional effects are simply neutralized by lexical-class semantics: a predication containing a CP verb entails transfer of possession irrespective of constructional context. By contrast, a predication containing a CM verb entails transfer of possession only in case of verb-construction conflict. CM verbs are ‘mismatched’ to the DC context; in order to resolve verb-construction conflict, the interpreter must construe the verb’s goal argument as a recipient in particular. Here we suggest that Gricean manner-based inference comes into play: the interpreter reasons that the user of this sentence had a good communicative rationale for using the DC pattern, as opposed to the more semantically congruent pattern for CM verbs, the OGC pattern. During this reasoning, the change-of-ownership scenario is likely to be more salient to the interpreter than it might be in concord (CP-DC) contexts.

In sum, frequency-based concord and lexical-semantic concord appear to exert opposing influences on simulation effects. Frequency-based concord facilitates mental reenactment of the denoted event: a verb in its preferred construction generates stronger simulation effects than one in a dispreferred construction. We presume that this difference is attributable to the manner in which interpretive resources are allocated during sentence understanding: when the verb is highly predictable in the context, verb and construction need not be retrieved separately, and the interpreter can expend more energy on mental reenactment. Somewhat surprisingly given the foregoing, lexical-semantic concord dampens motoric simulation: a CM verb in the ‘mismatched’ DC context generates stronger simulation effects than one in the concordant OGC context. Overall, the strongest differences between motor simulation effects in congruent and incongruent trials were seen in among DC predications, which uniformly entail a change of ownership (unlike OGC predications). We suggest that this asymmetry exists because coordinated actions like transfer of possession have more predictable mental reenactments than ‘single-party’ actions like instigation of motion.

Conclusion

Knowing a verb means knowing some things that are extrinsic to that verb: what semantic entailments it shares with other verbs, the constructions with which it prefers to combine and the contribution it makes to meaning construction. We find that simulation-based differences among verbs arise not only from lexical-class differences (divergent entailments), but also from the syntactic environments in which members of those lexical classes appear. The results of this experiment suggest not only that certain syntactic
environments (the DC and OGC) are associated with differing simulation effects, but also that lexical-class semantics may diminish or possibly negate these effects, as in the case of CP verbs occurring in the OGC context. These findings suggest that those looking for evidence of embodied representations in language comprehension should attend not only to lexeme distinctions, lexical-class distinctions and constructional meaning differences, but also to the interplay between lexeme and construction.

As mentioned earlier, the findings of this experiment have ramifications for methodological and experimental design within simulation semantics. The effects of both frequency-based concord and lexical-semantic concord should be taken into account in the design of stimuli. Thus, if one were to design a study similar to the one described here, but using only verbs that heavily favor the OGC, it is likely that OGC and DC would not diverge with respect to motor simulation effects. Similarly, because CP verbs have the effects they have regardless of constructional context, if one were to examine the motor simulation effects of OGC and DC using only CP verbs, simulation-based differences between the two constructions might not be apparent.

In addition, the findings of this study may contribute to the resolution of conflict between proponents of an embodied view of linguistic cognition and those who correctly observe that a theory of language understanding based solely on sensorimotor representation cannot account for abstract aspects of language understanding. It may be, as suggested by Zwaan (2014), that interpreters rely on symbolic representations (e.g., frame-semantic meanings of lexical items) during semantic composition, although these representations activate grounded representations. The present study suggests that various forms of linguistic representation—from verbs to verb classes to constructions—form a hierarchy of abstraction, ultimately grounded in embodied action. While all of the predications featured in this experiment depicted concrete instances of transfer, the argument arrays used in the stimuli (footballs, packages, and the like) accounted for only one level of semantic representation. There were, of course, two other levels of semantic representation that were shown to significantly modulate simulation results: (1) constructional meaning, and (2) lexical class membership. Although it would be inappropriate to categorize either form of semantic representation as purely abstract, it seems clear that they have been *abstracted* from concrete meanings. As Goldberg (2006) points out, children initially use constructions like the DC to describe literal instances of transfer of possession, after which they begin to generalize these syntactic configurations to contexts beyond those in which they were first encountered. In this process, constructions become more semantically abstract and generalizable, but retain vestiges of embodied meaning that are detectable into adulthood.

**References**


### Appendix A: Critical Stimuli Used in the Study

<table>
<thead>
<tr>
<th>Slide Text</th>
<th>Construction</th>
<th>Verb Bias (Ditransitive/Oblique Goal)</th>
<th>Verb Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>You are flinging Amy the frisbee.</td>
<td>Ditransitive</td>
<td>0.8125</td>
<td>Caused Motion</td>
</tr>
<tr>
<td>You are flinging Amy the plate.</td>
<td>Ditransitive</td>
<td>0.8125</td>
<td>Caused Motion</td>
</tr>
<tr>
<td>You are flipping Cathy the card.</td>
<td>Ditransitive</td>
<td>0.6666666667</td>
<td>Caused Motion</td>
</tr>
<tr>
<td>You are flipping Cathy the matchbook</td>
<td>Ditransitive</td>
<td>0.6666666667</td>
<td>Caused Motion</td>
</tr>
<tr>
<td>You are lobbing Lucas the bottle.</td>
<td>Ditransitive</td>
<td>0.4</td>
<td>Caused Motion</td>
</tr>
<tr>
<td>You are lobbing Lucas the egg.</td>
<td>Ditransitive</td>
<td>0.4</td>
<td>Caused Motion</td>
</tr>
<tr>
<td>You are sending Jason the package.</td>
<td>Ditransitive</td>
<td>0.47160789</td>
<td>Caused Motion</td>
</tr>
<tr>
<td>You are sending Jason the shoebox.</td>
<td>Ditransitive</td>
<td>0.47160789</td>
<td>Caused Motion</td>
</tr>
<tr>
<td>You are sliding Jenna the glass.</td>
<td>Ditransitive</td>
<td>0.851851852</td>
<td>Caused Motion</td>
</tr>
<tr>
<td>You are sliding Jenna the tray.</td>
<td>Ditransitive</td>
<td>0.851851852</td>
<td>Caused Motion</td>
</tr>
<tr>
<td>You are throwing Julie the football.</td>
<td>Ditransitive</td>
<td>0.980769231</td>
<td>Caused Motion</td>
</tr>
<tr>
<td>You are throwing Julie the orange.</td>
<td>Ditransitive</td>
<td>0.980769231</td>
<td>Caused Motion</td>
</tr>
<tr>
<td>You are tossing Erin the apple.</td>
<td>Ditransitive</td>
<td>0.545454545</td>
<td>Caused Motion</td>
</tr>
<tr>
<td>You are tossing Erin the hat.</td>
<td>Ditransitive</td>
<td>0.545454545</td>
<td>Caused Motion</td>
</tr>
<tr>
<td>You are flinging the frisbee to Curtis.</td>
<td>Oblique Goal</td>
<td>0.8125</td>
<td>Caused Motion</td>
</tr>
<tr>
<td>You are flinging the plate to Curtis.</td>
<td>Oblique Goal</td>
<td>0.8125</td>
<td>Caused Motion</td>
</tr>
<tr>
<td>You are flipping the card to Caleb.</td>
<td>Oblique Goal</td>
<td>0.6666666667</td>
<td>Caused Motion</td>
</tr>
<tr>
<td>You are flipping the matchbook to Caleb.</td>
<td>Oblique Goal</td>
<td>0.6666666667</td>
<td>Caused Motion</td>
</tr>
</tbody>
</table>
You are lobbing the bottle to Sophie.  Oblique Goal 0.4  Caused Motion
You are lobbing the egg to Sophie.  Oblique Goal 0.4  Caused Motion
You are sending the package to Wanda.  Oblique Goal 0.47160789  Caused Motion
You are sending the shoebox to Wanda.  Oblique Goal 0.47160789  Caused Motion
You are sliding the glass to Nicole.  Oblique Goal 0.851851852  Caused Motion
You are sliding the tray to Nicole.  Oblique Goal 0.851851852  Caused Motion
You are throwing the football to Ashley.  Oblique Goal 0.980769231  Caused Motion
You are throwing the orange to Ashley.  Oblique Goal 0.980769231  Caused Motion
You are tossing the apple to Kathleen.  Oblique Goal 0.545454545  Caused Motion
You are tossing the hat to Kathleen.  Oblique Goal 0.545454545  Caused Motion
You are giving Carla the gift.  Ditransitive 2.980433055  Caused Possession
You are giving Carla the money.  Ditransitive 2.980433055  Caused Possession
You are handing Steven the ball.  Ditransitive 0.615735462  Caused Possession
You are handing Steven the shirt.  Ditransitive 0.615735462  Caused Possession
You are lending Sally the key.  Ditransitive 0.498108449  Caused Possession
You are lending Sally the phone.  Ditransitive 0.498108449  Caused Possession
You are loaning Carmen the notebook.  Ditransitive 1.352941176  Caused Possession
You are loaning Carmen the pencil.  Ditransitive 1.352941176  Caused Possession
You are offering Jackie the basket.  Ditransitive 1.649122807  Caused Possession
You are offering Jackie the cake.  Ditransitive 1.649122807  Caused Possession
You are passing Lisa the folder.  Ditransitive 0.494163424  Caused Possession
You are passing Lisa the scissors.  Ditransitive 0.494163424  Caused Possession
You are showing Patrick the picture.  Ditransitive 4.134706815  Caused Possession
You are showing Patrick the wallet.  Ditransitive 4.134706815  Caused Possession
You are giving the gift to Francis.  Oblique Goal 2.980433055  Caused Possession
You are giving the money to Francis.  Oblique Goal 2.980433055  Caused Possession
You are handing the ball to Walter.  Oblique Goal 0.615735462  Caused Possession
You are handing the shirt to Walter.  Oblique Goal 0.615735462  Caused Possession
You are lending the key to Ernie.  Oblique Goal 0.498108449  Caused Possession
<table>
<thead>
<tr>
<th>Action</th>
<th>Oblique Goal</th>
<th>Caused Possession</th>
</tr>
</thead>
<tbody>
<tr>
<td>You are lending the phone to Ernie.</td>
<td>Oblique Goal</td>
<td>Caused Possession</td>
</tr>
<tr>
<td>You are loaning the notebook to Laurie.</td>
<td>Oblique Goal</td>
<td>Caused Possession</td>
</tr>
<tr>
<td>You are loaning the pencil to Laurie.</td>
<td>Oblique Goal</td>
<td>Caused Possession</td>
</tr>
<tr>
<td>You are offering the basket to Paula.</td>
<td>Oblique Goal</td>
<td>Caused Possession</td>
</tr>
<tr>
<td>You are offering the cake to Paula.</td>
<td>Oblique Goal</td>
<td>Caused Possession</td>
</tr>
<tr>
<td>You are passing the folder to Gerald.</td>
<td>Oblique Goal</td>
<td>Caused Possession</td>
</tr>
<tr>
<td>You are passing the scissors to Gerald.</td>
<td>Oblique Goal</td>
<td>Caused Possession</td>
</tr>
<tr>
<td>You are showing the picture to Jerry.</td>
<td>Oblique Goal</td>
<td>Caused Possession</td>
</tr>
<tr>
<td>You are showing the wallet to Jerry.</td>
<td>Oblique Goal</td>
<td>Caused Possession</td>
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</tbody>
</table>
## Appendix B: Non-Critical Stimuli Used in the Study

<table>
<thead>
<tr>
<th>Slide Text</th>
<th>Construction Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>You are agreeing Jimmy the menu.</td>
<td>Ditransitive</td>
</tr>
<tr>
<td>You are agreeing the menu to Charlie.</td>
<td>Oblique Goal</td>
</tr>
<tr>
<td>You are apologizing Betty the email.</td>
<td>Ditransitive</td>
</tr>
<tr>
<td>You are apologizing the email to Kyle.</td>
<td>Oblique Goal</td>
</tr>
<tr>
<td>You are appearing Geoffrey the restaurant.</td>
<td>Ditransitive</td>
</tr>
<tr>
<td>You are appearing the restaurant to Daryl.</td>
<td>Oblique Goal</td>
</tr>
<tr>
<td>You are arriving Janice the station.</td>
<td>Ditransitive</td>
</tr>
<tr>
<td>You are arriving the station to Rosie.</td>
<td>Oblique Goal</td>
</tr>
<tr>
<td>You are collapsing Alex the floor.</td>
<td>Ditransitive</td>
</tr>
<tr>
<td>You are collapsing the floor to Wilson.</td>
<td>Oblique Goal</td>
</tr>
<tr>
<td>You are colliding Ralphie the fence.</td>
<td>Ditransitive</td>
</tr>
<tr>
<td>You are colliding the fence to Trisha.</td>
<td>Oblique Goal</td>
</tr>
<tr>
<td>You are dancing Morgan the scene.</td>
<td>Ditransitive</td>
</tr>
<tr>
<td>You are dancing the scene to Layla.</td>
<td>Oblique Goal</td>
</tr>
<tr>
<td>You are disappearing Joelle the note.</td>
<td>Ditransitive</td>
</tr>
<tr>
<td>You are disappearing the note to Sandra.</td>
<td>Oblique Goal</td>
</tr>
<tr>
<td>You are emerging Jacob the artist.</td>
<td>Ditransitive</td>
</tr>
<tr>
<td>You are emerging the artist to Vinny.</td>
<td>Oblique Goal</td>
</tr>
<tr>
<td>You are existing Sadie the child.</td>
<td>Ditransitive</td>
</tr>
<tr>
<td>You are existing the child to Harold.</td>
<td>Oblique Goal</td>
</tr>
<tr>
<td>You are falling Kelsey the ice.</td>
<td>Ditransitive</td>
</tr>
<tr>
<td>You are falling the ice to David.</td>
<td>Oblique Goal</td>
</tr>
<tr>
<td>You are happening Miles the surprise.</td>
<td>Ditransitive</td>
</tr>
</tbody>
</table>
You are happening the surprise to Mary.
You are having Douglas the conversation.
You are having the conversation to Edward.
You are lasting Kaley the bicycle.
You are lasting the bicycle to Mickey.
You are laughing Michael the story.
You are laughing the story to Yvette.
You are living Hunter the conversation.
You are living the conversation to Olga.
You are looking Alan the child.
You are looking the child to Nadine.
You are lying Randy the tale.
You are lying the tale to Sigmund.
You are occurring Harper the idea.
You are occurring the idea to Asher.
You are remaining the scraps to Peter.
You are remaining Vicky the scraps.
You are responding Katie the question.
You are responding the question to Terry.
You are rising Reggie the morning.
You are rising the morning to Trevor.
You are searching Tammy the liquid.
You are searching the liquid to Percy.
You are sitting Krista the table.
You are sitting the table to Pierre.
You are sleeping Curtis the pillow.
You are sleeping the pillow to Hazel.
You are sneezing Heather the story.
You are sneezing the story to Lawrence.
You are snoring Jeffrey the whistle.
You are snoring the whistle to Christian.
You are standing Lindsey the chair.
You are standing the chair to Donald.
You are staying Bobby the room.
You are staying the room to Celia.
You are swimming Esther the ocean.
You are swimming the ocean to Andy.
You are vanishing Bella the rabbit.
You are vanishing the rabbit to Ellie.
You are waiting Elaine the taxi.
You are waiting the taxi to Freddie.