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ORIGINAL ARTICLE

Perspective in the conceptualization of categories

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Abstract

The ability to differently perceive and represent entities depending on their perspective is crucial for humans. We report five experiments that investigate how the different perspectives adopted while experiencing entities are reflected in conceptualizations (towards vs. away, near vs. far, beside vs. above, inside vs. outside and vision vs. audition vs. touch). Different groups of participants generated object properties while imagining the same scenario from different perspectives (e.g. entities coming toward them/going away from them while on a highway overpass). If conceptualizations have perspectives, then participants should produce features from a perspective entrenched in memory that reflects typical interactions with objects, independently of their assigned perspective (entrenched perspective). In addition, the perspective adopted in a given experiment should influence the properties generated (situated perspective). Results across the experiments indicate that conceptualizations contain both entrenched and situational perspectives. While entrenched perspectives emerge from canonical actions typically performed with objects, locations and entities, situational perspectives reflect online adaptations to current task contexts. The implications of the interplay between entrenched and situational perspectives for grounded cognition are discussed.

Introduction

The importance of perspective

During our interactions with objects, we often interact with them from different perspectives, with some perspectives being more common than others. For example, we generally interact with objects that are close to us rather than far away. We interact more frequently with people as they approach us than when they go away. We typically interact with people beside us rather than from above, unless we are at a window, are unusually tall, or are observing a child. Although some perspectives are less common than others, we nevertheless can take these unusual perspectives when relevant to our goals (e.g. perceiving objects going away from us).

The aim of the present work is to investigate whether the perspectives that we adopt while experiencing entities are reflected in our conceptualization of categories (Murphy, 2004). According to the now well-established grounded views, simulation constitutes one important process that underlies conceptual processing (Barsalou, 1999; 2016; Gallese and Lakoff, 2005; Glenberg, 2015; Wilson, 2002; for reviews, see Barsalou, 2008; Borghi and Caruana, 2015; Glenberg, Witt and Metcalfe, 2013; Martin, 2007; Matheson and Barsalou, 2018). Specifically, simulations result from the re-enactment of multimodal perceptual, motor and emotional experiences related to particular entities, allowing us to predict what to expect from them (Barsalou, 1999; Barsalou, Simmons, Barbey, and Wilson, 2003; Gallese, 2009; Pecher, Zeelenberg and Barsalou, 2003). For example, thinking of a "cat" would lead to the re-enactment of visual, tactile and auditory experiences—the cat's colour and shape, the smoothness of its fur, its meowing—and to the recruitment of the corresponding neural areas. Simulations have an important predictive function, representing diverse inferences about perceived categories. When perceiving a cat, for example, we might infer that the events of licking, purring, scratching, etc., are likely to occur. Crucially, these predictions vary widely depending on the perspective of the

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cat with respect to us. We can predict, for example, that a cat nearby would lick or scratch us, while these actions will not occur if we perceive a cat from far away. In the framework of grounded cognition, perspective is thus pivotal for the simulations underlying concepts and to the predictive inferences that follow from them.

Previous research on perspective taking

Much research on perspective addresses the roles of object-centred, egocentric, and geocentric frames in perspective taking (Levinson, 1996; 2003). Studies adopting a grounded view have shown that when we observe someone acting or interacting with objects, we tend to adopt an egocentric perspective: for example, participants are faster in responding when they observe hands in their own than in others' perspective (Bruzzo, Borghi and Ghirlanda, 2008; Jackson, Meltzoff, and Decety, 2006; Vogt, Taylor and Hopkins, 2003), with sensory cortex exhibiting greater bold responses for egocentric than for heterocentric views (Maeda, Kleiner-Fisman, and Pascual-Leone, 2002; Saxe, Jamal, and Powell, 2005). Nevertheless, we are social beings and thus readily take the point of view of others. When, for example, participants see two objects in presence of another person, and are asked about the location of one object with respect to the other, they may spontaneously adopt the other's perspective (Tversky and Hard, 2009). Perspective and perspective taking play especially important roles in research on social cognition and joint action (e.g. see the special issue edited by Hamilton, Kessler, and Creem-Regehr, 2014). Numerous studies, for example, address perspective taking while using language in conversation (e.g. Duran, Dale and Kreuz, 2011; Yoon, Koh and Brown-Schmidt, 2012), or while using language in presence of other people (Gianelli, Scorolli and Borghi, 2013; Galati and Avraamides, 2013). Further evidence demonstrates cultural differences in perspective taking. Collectivist cultures such as the Chinese tend to be better perspective takers than members of individualistic cultures such as Americans, suppressing egocentric tendencies and adopting others' point of view more quickly (Wu and Keysar, 2007; Wu, Barr, Gann and Keysar, 2013). Consistently, Asian Americans tend to adopt more easily the perspective of a friend or of an outsider, whereas Euro-Americans tend to represent the social situation from their own perspective (Leung and Cohen, 2007).

Given the importance of perspective taking for communication, a number of studies have investigated the linguistic devices useful in marking perspective and in signalling shifts of perspective (MacWhinney, 2005), including spatial prepositions, demonstratives, and pronouns. Spatial prepositions such as "to the left of," for example, induce perspectives (e.g. Kessler and Rutherford, 2010). Similarly, demonstratives such as "this/that" and "here/there" are associated with near vs. far space and with ego- vs. allocentric perspective (e.g. Coventry, Valdés, Castillo, and Guijarro-Fuentes, 2008; Coventry, Griffiths and Hamilton, 2014; Diessel, 2006). Recent research has also shown that different pronouns can lead to a shift in perspective: "I" and "you", for example, tend to activate the motor system more than third-person pronouns, presumably because they are compatible with the agent perspective (e.g. Brunyé, Ditman, Mahoney, Augustyn, and Taylor, 2009; Ditman, Brunyé, Mahoney, and Taylor, 2010; Gianelli, Farnè, Salemme, Jeannerod, and Roy, 2011; Gianelli, Marzocchi and Borghi, 2017; Papeo, Corradi-Dell'Acqua, and Rumiati, 2011; review in Beveridge and Pickering, 2013).

Perspective taking during conceptual processing

All of the studies on perspective taking just reviewed bear on the grounded perspective in various ways. Nevertheless, perspective taking in that work primarily addresses the ability to put ourselves in others' shoes, adopting others' point of view instead of an egocentric one. Notably, none of this work bears on the role of perspective taking during the processing of conceptual information. Because embodiment and other forms of grounding have been shown to be central to both perspective taking and the human conceptual system, it is likely that perspective plays central roles during conceptual processing. To our knowledge, the studies reported here are the first to address this issue. Specifically, the five studies to follow, using a common paradigm and method, investigate how different perspectives (towards vs. away, near vs. far, beside vs. above, inside vs. outside and vision vs. audition vs. touch) influence conceptual processing. In these studies, we only consider the egocentric (or relative) reference frame (i.e. the perspective of the agent), given its clear relevance to embodiment and situated action.

Overview and hypotheses

Across five experiments, participants were required to perform a primary detection task, assessing whether the concept in each trial was something that might be detected from a particular perspective. We chose the detection task because we wanted participants to simulate interacting or observing the entities from a given perspective. To perform the task, participants must simulate a situation from a particular perspective. As a consequence, we could observe the effect of the perspective adopted on the critical feature listing task.

In Experiment 1, for example, some participants were asked to assess whether each concept was something that could be seen coming towards them while standing on a highway overpass (e.g. car vs. submarine), whereas other participants were asked whether each concept was something that could be seen going away from them on the overpass. For each such question in an experiment, participants answered 'yes' or 'no' on the detection task for each specific concept presented (e.g. "yes" for car, "no" for submarine).

For a critical subset of the concepts in a given experiment, participants were also asked to perform a secondary property generation task (i.e. for 7 of the 21 concepts in Experiments 1–4, and 9 of the 27 concepts in Experiment 5). After performing the detection task in one of these critical trials, participants were asked to produce characteristics typically true of the concept for 10 s (e.g. the properties typically true of a car). The choice of using a feature generation task is justified by the fact that it is an implicit task that allows access to conceptual representation (Harpaintner, Trupp and Kiefer, 2018; McRae, Cree, Seidenberg, and McNorgan, 2005; Papies, 2013; Vanoverberghe and Storms, 2003; Wu and Barsalou, 2009), as testified by its use in various fields and disciplines. To reduce the salience of the feature listing task, we embedded it within the detection task, and instructed participants that the detection task was of primary importance. Additionally, following the attentional set literature, the majority of trials (67%) did not include feature listing, thereby establishing a cognitive set of only performing the detection task (e.g. Posner and Snyder, 1975): the property generation task only followed the detection task in one-third of the trials. Specifically, we wanted to avoid demand on participants to adopt a given perspective while generating features. From the participant's point of view, the detection task was of primary importance because it was performed first in every trial, with the property generation task only being of secondary relevance in a small subset of trials. Nevertheless, we hypothesized that the property generation task might be influenced implicitly by the perspective adopted in the detection task. Previous works namely suggest such influence (Anderson and Pichert, 1978; Black et al., 1979; Spivey and Geng, 2001). For example, Anderson (1975) tested recall of a story of participants who imagined either being the primary story character or a person watching the story from a high balcony; results showed that the perspective taken influenced the recall, leading participants in the balcony condition to report more far visual details and participants in the self condition to report more bodily details. As described shortly, the design and analyses allowed us to assess whether performance on the property generation task reflected demand.

To assess the effects of task perspective on the properties produced, different groups of participants generated object properties while imagining the same scenario from different perspectives during the detection task. In Experiment 1, one group of participants judged whether objects would be seen coming toward them while on a highway overpass, whereas a second group judged whether the objects would be seen going away from them. In Experiment 2, one group judged whether objects would be seen nearby in a restaurant, whereas another group judged whether they would be seen far away. In Experiment 3, one group judged whether objects would be seen while standing beside a skyscraper, whereas another group judged whether the objects would be seen from above while standing on top of the skyscraper. In Experiment 4, one group judged whether objects could be seen while being inside a building or vehicle (e.g. house, car), whereas another group judged whether the objects could be seen outside it. In Experiment 5, three different groups judged whether they would see, throw, or hear an object, respectively, while being in a backyard. While Experiments 1–4 addressed spatial perspectives, Experiment 5 focused on sensory perspectives. Spatial and sensory perspectives are often addressed separately in the literature. We decided to consider both of them here, because they are both crucial for a grounded perspective, with both central to how we perceive and interact with objects and entities in the world. We think that a systematic study on perspective should take both into account.

Again, in one-third of the trials across experiments, participants were subsequently asked to produce the properties typically true of the object after making a detection judgment. The items on which participants were required to generate properties were 7 in Experiments 1–4 and 9 in Experiment 5; the reduced number of items is due to the kind of task that required participants to produce properties. Each property protocol for a trial was transcribed and parsed into its featural components as described later. All features for a given concept within an experiment across perspectives were then integrated into a common feature norm for the concept, with each feature only included once. Naive independent raters then judged how much each property could be seen from each perspective in a given experiment.

Using the judges' average perspective ratings (as described later), the analyses performed for each experiment assessed four possible hypotheses about the effects of its perspective manipulation. First, the null hypothesis was that the properties produced would not show any effects of the perspective manipulated in the detection task. Second, the demand hypothesis was that participants would believe that they should produce features from the perspective adopted in the detection task, such that only features from their assigned perspective should be produced. In Experiment 1, for example, participants adopting the toward perspective should primarily produce features from the fronts of objects, whereas participants adopting the away perspective should primarily produce features from the backs of objects. Note, however, that because participants only received one perspective in an experiment, it is unlikely that they would realize that perspective was being manipulated across groups. Nevertheless, this is a possibility that is important to assess. Third, the entrenched perspective hypothesis was that participants would produce features from a perspective entrenched in memory that reflects typical interactions with objects, independently of their assigned perspective. In Experiment 1, for example, participants might implicitly adopt the toward perspective as the default, even when asked explicitly to adopt the away perspective, generally preferring to produce features from the front of objects, given that this is how people more frequently interact with them. It is essential to note that we do not claim that what we call the default perspective would necessarily be the dominant one across all concepts; we rather intend to test whether, among the two or three perspectives we introduced, one dominates the other(s) across all concepts. For example, people might interact with cars and trains from the side (i.e. where the doors are) more frequently encountered than from the front, but we intend to test whether the toward/front perspective dominates over the away perspective.

Fourth and finally, the situated perspective hypothesis was that the perspective adopted in a given experiment would influence the properties generated, with participants more likely to produce properties seen from their adopted perspective than from other perspectives. When adopting the away perspective in Experiment 1, for example, participants would become more likely to produce properties from the back of cars than from the front, relative to participants adopting the toward perspective.

The distinction between the demand and the situated perspective is a critical one. Although the demand and situated perspective hypotheses might seem to make the same predictions, they do not. If the demand hypothesis is correct, then the manipulated perspective should have an effect in every experiment—participants should generally believe that properties should be produced from their assigned perspective across experiments. Even if they were not explicitly instructed to produce properties according to a given perspective, participants would thus take into account the instructions they had just been given for the detection task.

If, however, the perspective manipulation only produces perspective effects in some experiments, this argues against the demand hypothesis. Additionally, the demand hypothesis is unable to explain any observed effects of entrenched perspectives. If features tend to be produced from one particular perspective across all perspectives manipulated in an experiment, this suggests that demand is not operating, given that a default perspective is operating instead. And again, the manipulation of perspective between groups reduces the possibility that attention would be drawn to the importance of perspective.

In general, we predicted that the observed results would support both the entrenched and situated hypotheses. On the one hand, entrenched hypotheses would operate regardless of the perspective adopted. On the other, the adopted perspective would operate as well, increasing the production of features relevant in the current task situation.

Experiment 1: towards vs. away

Experiment 1 assessed whether the representations of concepts differ when participants imagine seeing their referents coming towards or going away from them. The effects of task perspective (toward vs. away) and rated perspective (toward vs. away) were assessed on generated properties. Task perspective was manipulated by asking two different groups of participants to imagine themselves on a highway overpass, watching things either coming towards them or going away, respectively. In each trial of the detection task, participants had to indicate whether the presented concept would be something that they might observe from their assigned perspective. In a third of these trials, participants also generated properties of the object. Rated perspective was manipulated by having an additional group of independent raters evaluate the properties produced by the participants across both task perspectives, rating how likely it would be to experience each property if the object was coming towards them or going away. The details of this manipulation and its analysis follow later.

Because people typically interact with objects from the front, a grounded view of concepts predicts that the properties produced should exhibit an entrenched toward perspective, with toward properties generally being produced more often than away properties across both conditions. Additionally, we predicted that this entrenched perspective effect would be modulated by the situated perspective that participants were asked to adopt during the detection task.

Method

Design and participants

The experiment used a mixed design with the between-participants variable of task perspective having two levels (towards vs. away), and the within-participants variable of rated perspective also having two levels (towards vs. away). Participants (32) and concepts (7) were included as random factors, with 16 participants randomly assigned to each task perspective. Because all five experiments reported here were run simultaneously, participants were actually assigned randomly to conditions across all experiments, making conditions across experiments directly comparable. Participants were 32 students at the University of Chicago, all English native speakers. Participants were recruited on campus by an experimenter and volunteered for their participation, not receiving compensation.

Materials

Seven basic-level concepts were selected whose properties vary if they are viewed while coming towards an observer or going away. While a woman's smile and eyes can be perceived when she comes towards the observer, her hair and back can be better perceived if she is going away. The seven selected concepts were woman, policeman, car, horse, clown, train, and elephant. All their referents could be viewed coming toward an observer on a highway overpass or going away. The critical concepts represented 1/3 of all the concepts presented, with the remaining 14 concepts being fillers. Of the 21 concepts, 11 could be seen going in either direction from a highway overpass (e.g. woman, cart, bicycle), and 10 could not (e.g. submarine, church, market). Two random orders of the 21 concepts were constructed.

Procedure

Participants were told that they would be asked to answer to simple questions about various kinds of things that occur in the world, and that their answers would be tape recorded. Participants were further told that they would be asked to perform a detection task. Specifically, participants were told that they would hear the names of various things and have to indicate by a 'yes' or 'no' response whether the thing would likely be seen coming (or going) from a highway overpass. For the seven critical concepts, participants were also asked to perform the property generation task. A participant's responses on both tasks were tape recorded and extracted later for analysis.

"Ok, in a moment, I will ask you a series of questions about various kinds of things that occur in the world. I will ask you to imagine that you are standing on an overpass looking down at a highway. Then I will ask whether you might see a particular thing coming towards you. For both conditions, the instructions continued, "For example, I might ask, Could a dog be something coming towards you? Your job will be to answer "yes" or "no" to this question. So, for dog you should say "Yes". In some cases, I will also ask you what characteristics are typically true of this thing. So, for dog you might say: "Eyes, tail, runs, friendly". When I ask you about the characteristics of something, please continue listing them for 10 s. Do you have any questions?

Here's the first question:—Imagine you're on a overpass, watching things come towards you on a highway. Could (a) [concept] be something coming towards you?"

For the away task perspective, the instructions were: "Imagine you're on an overpass, watching things go away from you on a highway. Could (a) [concept] be something going away from you?" For the critical items, participants were then asked: "What characteristics are typically true of (a) [concept]?" After any pause participants were asked: "Can you think of any other characteristics?" For each question, the experimenter continued prompting the subject until 10 s have passed.

Data preparation

Concept norm construction

A concept norm was constructed for each of the seven critical concepts used in property generation trials. Each norm contained all the properties generated by at least one participant, with each property generated by multiple participants only included once. To create the norm for each concept, the tape-recorded protocol for each property generation trial was transcribed and parsed into properties. Whenever a verb and one or more arguments were generated as a property, the verb and each argument counted as one separate feature (e.g. "put in a glass" was separated into "put" and "into a glass"). For the coding analyses later, however, the surrounding context of the verb or argument was placed in parentheses, so that coders would know the context in which each verb or argument had been generated (e.g. "put (in a glass)", "(put) in a glass"). Raters were asked to rate the feature not in parentheses, while using the content in parentheses to better understand it. All words within a noun phrase were kept together as a single property (e.g. "red nose"). Different forms of a property involving the same noun, however, were combined together (e.g. "nose" and "red nose"), with judges rating each set of forms for a noun as a single property.

Property ratings

To assess whether the two different perspectives adopted in Experiment 1 affected the features produced, six independent raters evaluated the likelihood that the properties in the norm for each concept would be experienced from a particular perspective (using a scale from 1 to 7, where 1 indicated not at all, 4 indicated somewhat, and 7 indicated completely). It is perhaps worth noting that the number of judges is quite high compared to the majority of studies employing feature generation tasks, in which reliability is typically computed across 2–3 judges (e.g. Harpaintner, Trumpp and Kiefer, 2018; Wu and Barsalou, 2009). It is also important to stress that, differently from the majority of the experiments using feature generation tasks, in our study, all judges were unaware of the experimental hypotheses. Finally, instead of asking the judges to assign each produced feature to a given category (e.g. taxonomic associate), we asked him/her to use a seven-point scale to perform their evaluations. This should in principle increase the variability of their judgments. In spite of this, the means remain quite stable across the experiments, testifying to the reliability of our data.

Specifically, in "Experiment 1" judges rated each property, first, for the likelihood of seeing it when the object is coming towards them, and second, for the likelihood of seeing it when the object is going away from them. For example, judges tended to rate properties on the front of cars as more likely to be seen when cars were coming toward them than when going away (e.g. windshield); conversely, judges tended to rate properties on the back of cars as more likely to be seen when cars were going away from them (e.g. trunk).

Six raters, each paid $10 for participation, received each concept norm from Experiment 1, with the concepts and properties in random orders. Prior to beginning the rating task for each concept norm, raters read the following instructions: "Imagine that you are on a freeway overpass, looking down at a [concept] going by on the highway." The raters then evaluated each property in the norm for the relevant concept twice for: (1) How much you would experience this property if a [concept] was coming towards you (toward rated perspective)? (2) How much you would experience this property if a [concept] was going away from you (away rated perspective)?

A correlation was computed, to test the degree of overlap between the two task perspectives. The mean correlation between the average ratings for the two perspectives was 0.72. We will see that the correlation level varied consistently across the studies, and that the correlation strength between the two perspectives can help explaining the influence of the task perspective on the conceptual representation (see "Discussion"). Notice that this correlation was quite high, indicating that the judges' rated likelihood of perceiving a property was quite similar from the two perspectives. Each of the six raters evaluated the concept norms for all of the remaining experiments as well (i.e. not only for Experiment 1). For each rater, the order of the five experiments, its critical concepts, and the properties in each concept norm were randomized. Thus, each rater had to open a different file for each concept of each experiment following a different random order.

The data are available at the following link https://osf.io/6udte/?view_only=bd682353287d4a0e983b1d618f303682.

Statistical analysis

Originally, we attempted to perform all of the analyses to follow using linear mixed-effects models that included both participants and concepts as random effects. Problematically, many of these analyses failed to converge, presumably because of non-homogeneous variance (a common problem with these models). Thus, we instead performed two separate versions of every analysis, one modelling participants as a random effect (averaging over concepts), and the other modelling concepts as a random effect (averaging over participants).

Each of the analyses reported later assessed fixed effects for: (1) rated perspective (toward, away), (2) task perspective (toward, away), and (3) the interaction between rated and task perspective. While rated perspective was the perspective that raters took when rating the properties in the concept norms, task perspective was the perspective that participants were assigned in the detection task. How we assessed each fixed effect is described in turn, together with how they were used to test the hypotheses just presented.

Using effects of rated perspective to establish entrenched perspectives

We assessed the fixed effect of rated perspective to assess our hypothesis that an overall entrenched toward perspective exists in memory for the properties of concepts (independent of task instructions). If this hypothesis is correct, then an effect of rated perspective should occur for participants in both the toward (T) and away (A) groups.

To assess whether an effect of rated perspective was present, we computed the following difference score, Δ_{T-A}, for each property in the norm for every concept:

$$\Delta_{T-A} = M_T - M_A,$$

where M_T is the average toward rating of the six raters for the property, and M_A is the average away rating of the six raters for the same property. To the extent that properties were overall more likely to be represented from the toward perspective than from the away perspective, the average Δ_{T-A} across properties should be significantly greater than 0 (generally positive). Conversely, if the properties were more likely to be represented from the away perspective, the average Δ_{T-A} should be significantly less than 0 (generally negative).

To test for a rated perspective effect across participants as a random factor, an overall difference in rated perspective, $P_i\Delta_{T-A}$, was computed for each participant, P_i. To compute this overall measure, the Δ_{T-A} for each specific property that the participant produced for each of the seven critical concepts was first computed, using M_T and M_A from the six raters. The average Δ_{T-A} was then computed for each critical concept's properties, with these averages in turn averaged to produce the overall $P_i\Delta_{T-A}$ for the participant across concepts. Because participants tended to produce different numbers of properties for the same concept, the Δ_{T-A} tended to be computed across different numbers of properties for different participants, although M_T and M_A for the same property were always the same across participants. A t test then assessed whether the 16 $P_i\Delta_{T-A}$ for the participants in a given task group (receiving the toward vs. away instructions)

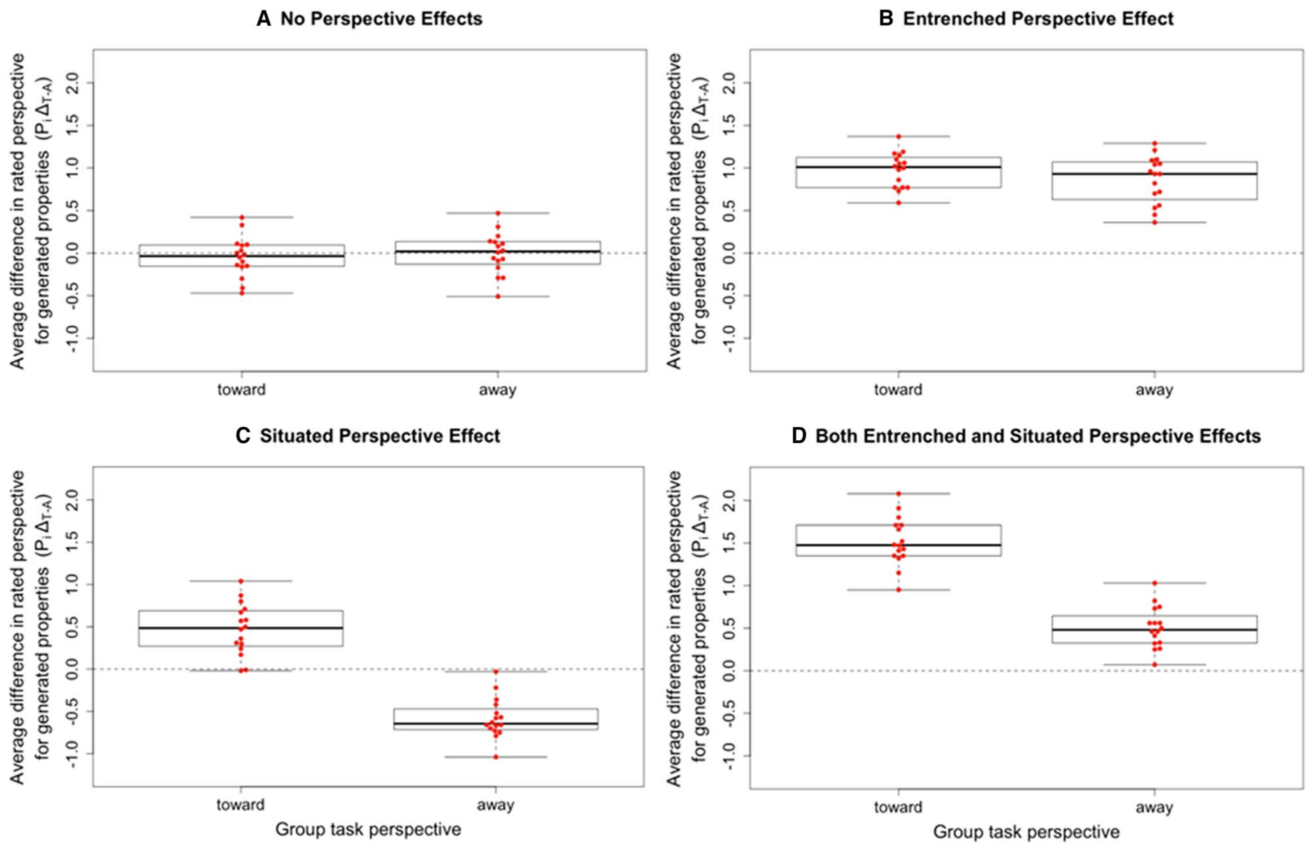

Fig. 1 Predicted patterns of overall difference scores, $P_i\Delta_{T-A}$, for hypotheses of interest in Experiment 1 (shown for 16 simulated participants in each panel). **a** For the null hypothesis, no effect of rated perspective and no effect of task perspective for the toward perspective relative to the away perspective. **b** For an entrenched toward perspective only, an effect of rated perspective but no effect of task perspective. **c** For a situated toward perspective only, no effect of rated perspective but an effect of task perspective. **d** For both entrenched and situated toward perspectives, an effect of rated perspective and an effect of a task perspective. Each box plot displays the median, inter-quartile range, and range for the 16 simulated participants in the respective task group

differed significantly from 0. Because we predicted a priori that there would be an entrenched toward perspective effect, we used a one-tailed directional test to assess whether the 16 $P_i\Delta_{T-A}$ in a group were significantly greater than 0.

The same hypothesis was also assessed using concepts as a random factor. For each concept, C_j, an overall mean difference score, $C_j\Delta_{T-A}$, was computed. To compute this overall score, the average Δ_{T-A} for each participant, P_i, was computed first. To compute this preliminary average, all the Δ_{T-A} were first computed for the properties that a given participant produced for the concept, with these Δ_{T-A} then being averaged. Next these concept averages for the 16 participants were averaged to produce the overall $C_j\Delta_{T-A}$ for the concept. Finally, the seven $C_j\Delta_{T-A}$ for the seven concepts were submitted to a one-tailed t test to assess the directional hypothesis that the $C_j\Delta_{T-A}$ was significantly greater than 0, reflecting a bias to produce properties consistent with an entrenched toward perspective.

Using simulated data, Fig. 1 illustrates how we used the values for $P_i\Delta_{T-A}$ and $C_j\Delta_{T-A}$ to assess the hypotheses presented earlier. In Panel A, the $P_i\Delta_{T-A}$ for 16 simulated participants are plotted simultaneously as box plots and bee swarms, with the plot for the toward task group on the left, and the plot for the near task group on the right. Because the $P_i\Delta_{T-A}$ for the two groups are not generally greater than 0, an entrenched toward perspective is not present. In other words, the properties that each group produced were not rated as more likely to be observed from the toward perspective than from the away perspective. Conversely, Panel B in Fig. 1 illustrates an entrenched toward perspective. Because the plots for both groups are generally greater than 0, this means that the properties for each group were more likely to be observed coming toward the perceiver than going away.

Using effects of task perspective to establish situated perspectives

While an effect of rated perspective indicates an entrenched perspective bias in memory across tasks, an effect of task perspective indicates a situated perspective bias. Consider

Experiment 1. If the instructions that participants received during the detection task—adopt either the toward or away perspective—differentially affected the properties that they generated for a concept, then the $P_i\Delta_{T-A}$ and $C_j\Delta_{T-A}$ just described should be significantly greater for the toward group than for the away group. If the toward and away instructions created perspective-dependent simulations of the critical concepts, then the properties produced in the toward condition should be rated as more likely to be observed from the toward perspective than the properties produced in the away condition. Conversely, properties produced in the away condition should be rated as more likely to be observed from the away perspective than properties produced in the toward condition.[1]

Using simulated data for 16 participants, Panel C in Fig. 1 illustrates a task perspective effect in the absence of a rated perspective (entrenched) effect. As can be seen, the $P_i\Delta_{T-A}$ for the toward group are greater than those for the away group, indicating that the task instructions influenced the perspective of the properties produced. Because the average of the two groups is essentially 0, there is no overall advantage for toward properties to be produced across groups. Thus, only an effect of the situated task perspective exists, not an overall effect of an entrenched perspective in memory.

Finally, again using simulated data, Panel D illustrates the presence of both an entrenched (rated) perspective and a situated (task) perspective. As can be seen, the $P_i\Delta_{T-A}$ for both the toward and Near groups are clearly above 0, indicating that, across groups, an entrenched perspective effect is present. Additionally, however, an effect of task perspective is also present, with the $P_i\Delta_{T-A}$ for the toward group being greater than those for the away group. Thus, the toward perspective has produced both an entrenched perspective effect and a situated perspective effect on the properties produced. Not only are properties in memory more likely to reflect the toward perspective, the task modulates this bias, biasing the presence of toward and away properties in the respective task conditions.

Assessing the demand hypothesis

As described earlier, the demand hypothesis makes the same basic prediction as the situated perspective hypothesis. If demand is operating, participants should primarily produce properties from their instructed perspective. In Experiment 1, for example, participants in the toward group should be more likely to generate properties consistent with the toward perspective, whereas participants in the away group should be more likely to generate properties from the away perspective. In other words, there should be an effect of task perspective as just described. As mentioned earlier, however, the demand hypothesis predicts that every experiment should exhibit an effect of task perspective, and is unable to explain effects of entrenched (rated) perspective. Additionally, the between group manipulation further makes it unlikely that participants would discern the purpose of the experiment, given that they received only one level of the task manipulation.

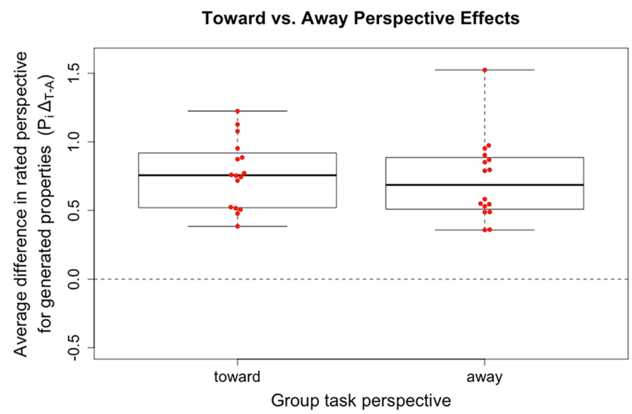

Fig. 2 Results from Experiment 1 showing overall difference scores, $P_i\Delta_{T-A}$, for properties generated by participants taking the toward task perspective (T) vs. the away task perspective (A) (16 participants per group). $P_i\Delta_{T-A}$ represent the difference in rated likelihood of perceiving the properties generated in each group from the toward vs. away perspectives

Results

Figure 2 presents the critical results from Experiment 1. Although Fig. 2 only shows results from the participant analyses, the text presents results from both the participant and concept analyses. Table 1 presents the average number of properties that participants generated in each condition.

As described in the "Statistical analysis" section, overall difference scores between ratings for the toward and away perspectives were computed for participants and concepts ($P_i\Delta_{T-A}$, $C_j\Delta_{T-A}$) and submitted to t tests that assessed the directional hypotheses of interest. Table 2 presents the average perspective ratings for the individual conditions that underlie the difference scores.

As Fig. 2 illustrates, an entrenched toward perspective effect occurred, with no situated perspective effect of task instructions. Consistent with an entrenched toward perspective, properties produced in both the toward and away groups

[1] Because a neutral baseline was not included, we cannot determine whether toward instructions increased the presence of toward features, whether away instructions increased the presence of away features, or both. Thus, the presence of a situated perspective effect simply indicates that the toward–away task manipulation altered property generation in the predicted direction (given our directional one-tailed tests). Similar assumptions underlie the task manipulations in later experiments.

Table 1 Mean number of properties that a participant generated for a concept in a property generation trial

Experiment/condition	Mean	SD
Experiment 1		
Toward	7.52	3.16
Away	7.36	2.07
Experiment 2		
Near	6.73	2.29
Far	7.32	1.97
Experiment 3		
Beside	6.10	2.05
Above	6.63	1.51
Experiment 4		
Inside	8.11	2.37
Outside	7.87	3.18
Experiment 5		
Vision	7.42	2.49
Touch	6.77	2.02
Audition	7.07	2.32

were rated as more likely to be perceived from the toward perspective. In the participants' analysis, the $P_i\Delta_{\text{T-A}}$ were significantly greater than 0 both for the toward group ($P_{\bar{x}}\Delta_{\text{T-A}} = 0.77$; $t(15) = 12.41$, SE = 0.06, $p < 0.0001$, $d = 3.10$) and for the away group ($P_{\bar{x}}\Delta_{\text{T-A}} = 0.72$; $t(15) = 9.70$, SE = 0.07, $p < 0.0001$, $d = 2.42$). In the concepts analysis, the $C_j\Delta_{\text{T-A}}$ was also significantly greater than 0 both for the toward group ($t(6) = 4.27$, SE = 0.18, $p < 0.0025$, $d = 1.61$) and for the away group ($t(6) = 3.69$, SE = 0.20, $p = 0.005$, $d = 1.39$).[2]

Failing to support a situated perspective effect, properties produced in the toward group were not rated as having a greater toward perspective than properties produced in the away group. Specifically, the $P_i\Delta_{\text{T-A}}$ were not significantly larger for the toward group than for the away group, either in the participants analysis ($P_{\overline{\text{T-A}}} = 0.05$; $t(30) = 0.47$, SE = 0.10, $p = 0.32$, $d = 0.17$) or in the concepts analysis ($t(6) = 0.73$, SE = 0.06, $p = 0.25$, $d = 0.28$).[3]

Discussion

The results of Experiment 1 suggest the presence of an entrenched toward perspective during the representation of object concepts. In both the toward and away groups, the properties generated were more likely to be perceived from the toward perspective than from the away perspective. This effect suggests that participants tended to represent objects conceptually with properties perceived from the fronts of objects relative to their backs.

The presence of an entrenched toward perspective is consistent with the theoretical position that conceptual representations are grounded in action. Because people typically interact with objects that are oriented towards them, it makes sense that people would tend to represent objects from this perspective.

No evidence for a situated task perspective occurred. Adopting a toward vs. away task perspective did not modulate the strength of the entrenched toward perspective. In the "General Discussion", we offer an explanation for the lack of a situated perspective here and Experiment 2 that also explains their presence in Experiments 3, 4, and 5.

The results are not consistent with the demand hypothesis. If the task instructions had created demand to produce properties from one perspective or the other, only an effect of situated task perspective should have been observed. Because task instructions were manipulated between participants, demand to adopt a particular perspective may not have been salient. Most importantly, the absence of a potential demand effect here suggests more generally that demand is not a problem in this paradigm.

Experiment 2: near vs. far

Experiment 2 assessed whether the representations of concepts differ when participants imagine seeing their referents nearby vs. far away. The effects of task perspective (near vs. far) and rated perspective (near vs. far) were assessed on generated properties. Task perspective was manipulated by asking two different groups of participants to imagine either being inside a restaurant and seeing the critical objects on the table in front of them (near), or being in line to get into a restaurant and seeing the objects on a table in the distance inside the restaurant (far). In each trial of the detection task, participants had to indicate whether the presented concept would be something that they might observe from their assigned perspective. In a third of these trials, participants also generated properties of the object. Rated perspective was manipulated by having an additional group of raters evaluate the properties produced by the participants across both task perspectives, rating how likely it would be to experience each property near vs. far in the restaurant.

[2] In the participants analysis, $P_{\bar{x}}\Delta_{\text{T-A}}$ is the mean value across the 16 $P_i\Delta_{\text{T-A}}$. In the concepts analysis, the analogous mean, $C_{\bar{x}}\Delta_{\text{T-A}}$, is always identical to $P_{\bar{x}}\Delta_{\text{T-A}}$ in the participants analysis, and so is not shown. These conventions are followed in all later analyses and experiments.

[3] $P_{\overline{\text{T-A}}}$ indicates the average difference in the $P_{\bar{x}}\Delta_{\text{T-A}}$ between the toward and away groups. In the concepts analysis, the analogous average difference, $C_{\overline{\text{T-A}}}$, is always identical to $P_{\overline{\text{T-A}}}$ in the participants analysis, and so is not shown. These conventions are followed in all later analyses and experiments.

Table 2 Mean perspective rating (and SD) across generated properties for each perspective and each task for each pair of perspectives in an experiment

Experiment 1	Toward task		Away task	
	Toward ratings	Away ratings	Toward ratings	Away ratings
Mean	4.37	3.62	4.48	3.76
SD	0.53	0.38	0.50	0.49
Experiment 2	**Near task**		**Far task**	
	Near ratings	Far ratings	Near ratings	Far ratings
Mean	5.40	2.71	5.72	2.80
SD	0.78	0.21	0.23	0.27
Experiment 3	**Beside task**		**Above task**	
	Beside ratings	Above ratings	Beside ratings	Above ratings
Mean	5.44	2.79	5.46	3.00
SD	0.20	0.18	0.30	0.28
Experiment 4	**Inside task**		**Outside task**	
	Inside ratings	Outside ratings	Inside ratings	Outside ratings
Mean	5.61	2.78	4.90	3.78
SD	0.27	0.37	0.62	0.67

Experiment 5	Vision Task		
	Vision ratings	Touch ratings	Audition ratings
Mean	5.05	3.65	2.17
SD	0.27	0.21	0.11
	Touch task		
	Vision ratings	Touch ratings	Audition ratings
Mean	4.72	3.65	2.24
SD	0.31	0.18	0.19
	Audition task		
	Vision ratings	Touch ratings	Audition ratings
Mean	4.59	3.49	2.51
SD	0.44	0.27	0.33

Because people typically interact with objects up close, a grounded view of concepts predicts that the properties produced should exhibit an entrenched near perspective, with near properties generally being produced more often than far properties across both conditions. Additionally, we predicted that this entrenched perspective effect would be modulated by the situated perspective that participants were asked to adopt during the detection task.

Method

Design and participants

The experiment used a mixed design with the between-participants variable of task perspective having two levels (near vs. far), and the within-participants variable of rated perspective also having two levels (near vs. far). Participants

(32) and concepts (7) were included as random factors, with 16 participants randomly assigned to each task perspective. Participants were 32 students at the University of Chicago, all English native speakers. Participants were recruited on campus by an experimenter and volunteered for their participation, not receiving compensation.

Materials

Seven basic-level concepts were selected whose properties vary if they are viewed from far vs. near. While round and flat for a pizza can be seen from far away, other properties can be better experienced when nearby, such as oil, tomatoes, and tastes good. The seven selected concepts were pizza, menu, flower, soup, salad, pineapple, and sandwich. All could be seen nearby on a restaurant table or from far away. The critical concepts represented 1/3 of all the concepts presented, with the remaining 14 concepts being fillers. Of the 21 concepts, 11 could be seen on a table in a restaurant (e.g. pizza, candle, chicken), and 10 could not (e.g. siren, elephant, shovel). Two random orders of the 21 concepts were constructed.

Procedure

The procedure was the same as in the previous experiment, except for the task perspective instructions. For the near task perspective, participants were asked, "If you were in a restaurant, is [concept] something that a waiter might put right in front of you on your table?" For the far task perspective, participants were asked, "If you were in line to get into a restaurant, is [concept] something that you might see across the waiting area, on a table, in the interior of the restaurant?" For every concept, participants responded 'yes' or 'no' to the relevant detection question. When subsequently probed on the critical trials, participants generated the concept's properties for 10 s.

Results

The concept norms, property ratings, and statistical analyses were analogous to those in Experiment 1, unless noted otherwise. The same judges who rated properties in Experiment 1 also rated the properties generated in this experiment, except on different scales. Here, the judges were first asked, "Imagine that you are at a restaurant, and [concept] is present." The judges then rated each property on a seven-point scale twice for: (1) How much would you experience the property if you were sitting at a table in the restaurant's interior and a [concept] was just in front of you on the table (near rated perspective)? (2) How much would you experience the property if you were standing in the restaurant's waiting area and a [concept] was far from you on a table in the restaurants' interior (far rated perspective)? The mean correlation between the average ratings for the two perspectives was 0.48.

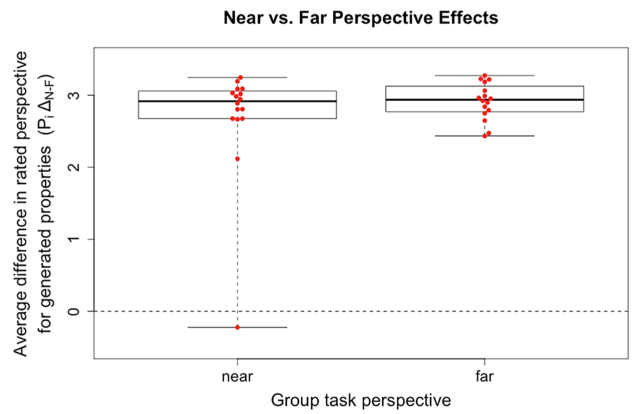

Fig. 3 Results from Experiment 2 showing overall difference scores, $P_i\Delta_{N\text{–}F}$, for properties generated by participants taking the near task perspective (N) vs. the far task perspective (F) (16 participants per group). $P_i\Delta_{N\text{–}F}$ represents the difference in rated likelihood of perceiving the properties generated in each group from the near vs. far perspectives

Figure 3 presents the critical results from Experiment 2. Although Fig. 3 only shows results from the participant analyses, the text presents results from both the participant and concept analyses. Table 1 presents the average number of properties that participants generated in each condition.

As described in the "Statistical Analysis" section, overall difference scores between ratings for the near (N) and far (F) perspectives were computed for participants and concepts ($P_i\Delta_{N\text{–}F}$, $C_j\Delta_{N\text{–}F}$) and submitted to t tests that assessed the directional hypotheses of interest. Table 2 presents the average perspective ratings for the individual conditions that underlie the difference scores.

As Fig. 3 illustrates, an entrenched near perspective effect occurred, with no situated perspective effect of task instructions. Consistent with an entrenched near perspective, properties produced in both the near and far groups were rated as more likely to be perceived from the near perspective. In the participants analysis, the $P_i\Delta_{N\text{–}F}$ were significantly greater than 0 both for the near group ($P_{\bar{x}}\Delta_{N\text{–}F} = 2.69$; $t(15) = 13.08$, SE = 0.21, $p < 0.0001$, $d = 3.27$) and for the far group ($P_{\bar{x}}\Delta_{N\text{–}F} = 2.91$; $t(15) = 45.86$, SE = 0.06, $p < 0.0001$, $d = 11.46$). In the concepts analysis, the $C_j\Delta_{N\text{–}F}$ were also significantly greater than 0 both for the near group ($t(6) = 16.38$, SE = 0.16, $p < 0.0001$, $d = 6.19$) and for the far group ($t(6) = 15.96$, SE = 0.18, $p = 0.0001$, $d = 6.03$).

Failing to support a situated perspective effect, properties produced in the near group were not rated as having a greater near perspective than properties produced in the far group. Indeed, the difference was in the unpredicted direction, not significant in the participants analysis but significant in the concepts analysis. Specifically, the $P_i\Delta_{\text{N-F}}$ were not significantly larger for the near group than for the far group in the participants analysis ($P_{\overline{N-F}} = -0.22$; $t(30) = 1.05$, SE = 0.22, $p = 0.15$, $d = 0.37$) but were significantly larger in the concepts analysis ($t(6) = 4.02$, SE = 0.06, $p = 0.0035$, $d = 1.61$). Again, this pattern does not support our directional prediction that near instructions would bias property generation of near properties, and that far instructions would bias property generation of far properties. Thus, our results only indicate the presence of an entrenched perspective effect.

Discussion

The results of Experiment 2 suggest the presence of an entrenched near perspective during the representation of object concepts. In both the near and far groups, the properties generated were more likely to be perceived from the near perspective than from the far perspective. This effect suggests that participants tended to represent objects conceptually with properties perceived from being nearby objects relative to being far away.

The presence of an entrenched near perspective is consistent with the theoretical position that conceptual representations are grounded in action. Because people typically interact with objects up close, it makes sense that people would tend to represent them from this perspective.

No evidence for a situated task perspective occurred. Adopting a near vs. far task perspective did not modulate the strength of the entrenched near perspective. In the "General Discussion", we offer an explanation for the lack of a situated perspective here and Experiment 1 that also explains their presence in Experiments 3, 4, and 5. Again, the results are not consistent with the demand hypothesis. If the task instructions had created demand to produce properties from one perspective or the other, an effect of situated task perspective should have been observed.

Experiment 3: beside vs. above

Experiment 3 assessed whether the representations of concepts differ when participants imagine being beside their referents vs. being above them. The effects of task perspective (beside vs. above) and rated perspective (beside vs. above) were assessed on generated properties. Task perspective was manipulated by asking two different groups of participants to imagine being on a sidewalk next to a skyscraper (near and low) or on top of a skyscraper looking down at the sidewalk far below (far and high). In each trial of the detection task, participants had to indicate whether the presented concept would be something that they might observe from their assigned perspective. In a third of these trials, participants also generated properties of the object. Rated perspective was manipulated by having an additional group of raters evaluate the properties produced by the participants across both task perspectives, rating how likely it would be to experience each property while being beside it vs. above it.

Because we typically interact with objects while being beside them, a grounded view of concepts predicts that the properties produced should exhibit an entrenched beside perspective, with beside properties generally being produced more often than above properties across both conditions. Additionally, we predicted that this entrenched perspective effect would be modulated by the situated perspective that participants were asked to adopt during the detection task.

Method

Design and participants

The experiment used a mixed design with the between-participants variable of task perspective having two levels (beside vs. above), and the within-participants variable of rated perspective also having two levels (beside vs. above). Participants (32) and concepts (7) were included as random factors, with 16 participants randomly assigned to each task perspective. Participants were 32 students of the University of Chicago, all English native speakers. Participants were recruited on campus by an experimenter and volunteered for their participation, not receiving compensation.

Materials

Seven basic-level concepts were selected whose properties vary if they are viewed from above at a distance vs. nearby at the same level. While the property of directing traffic can be seen for a policeman above from afar, a whistle can be viewed better at the same level nearby. The seven selected concepts were policeman, motor biker, newspaper stand, taxi, woman, tree, and store. All could be seen nearby beside a skyscraper on the ground or far away from above. The critical concepts represented 1/3 of all the concepts presented, with the remaining 14 concepts being fillers. Of the 21 concepts, 11 could be seen on a sidewalk near a skyscraper (e.g. policeman, street light, dog), and 10 could not (e.g. submarine, island, desert). Two random orders of the 21 concepts were constructed.

Procedure

The procedure was the same as in the previous experiments, except for the task perspective instructions. For the beside task perspective, participants were asked, "If you're standing on a sidewalk next to a skyscraper, is [concept] something that you might see next to you?" For the above task perspective, participants were asked, "If you're standing on top

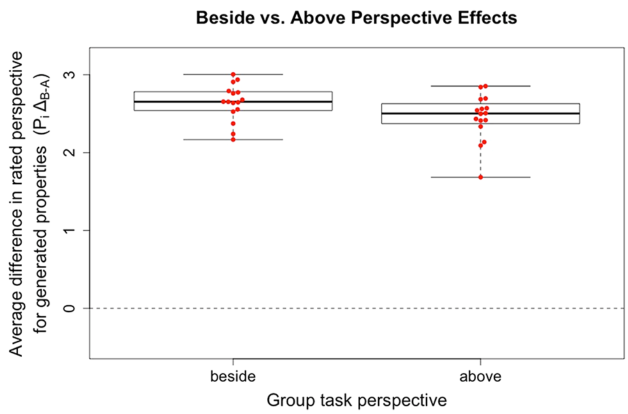

Fig. 4 Results from Experiment 3 showing overall difference scores, $P_i\Delta_{B-A}$, for properties generated by participants taking the beside task perspective (B) vs. the far task perspective (A) (16 participants per group). $P_i\Delta_{B-A}$ represents the difference in rated likelihood of perceiving the properties generated in each group from the beside vs. above perspectives

of a skyscraper looking down at the sidewalk far below, is [concept] something that you might see?" For every concept, participants responded 'yes' or 'no' to the relevant detection question. When subsequently probed on the critical trials, participants generated the concept's properties for 10 s.

Results

The concept norms, property ratings, and statistical analyses were analogous to those in Experiment 1, unless noted otherwise. The same judges who rated properties in the previous experiments also rated the properties generated in this experiment, except on different scales. Here, the judges were first asked, "Imagine that you visiting a skyscraper and a [concept] is present." The judges then rated each property on a seven-point scale twice for: (1) How much would you experience the property if you were standing on the ground beside the skyscraper. with the [concept] near you on the sidewalk (beside rated perspective)? (2) How much would you experience the property if you were standing on top of the skyscraper, looking down at the [concept] on the sidewalk below (above rated perspective)? The mean correlation between the average ratings for the two perspectives was 0.43.

Figure 4 presents the critical results from Experiment 2. Although Fig. 4 only shows results from the participant analyses, the text presents results from both the participant and concept analyses. Table 1 presents the average number of properties that participants generated in each condition.

As described in the "Statistical Analysis" section, overall difference scores between ratings for the beside (B) and above (A) perspectives were computed for participants and concepts ($P_i\Delta_{B-A}$, $C_j\Delta_{B-A}$) and submitted to t tests that assessed the directional hypotheses of interest. Table 2 presents the average perspective ratings for the individual conditions that underlie the difference scores.

As Fig. 4 illustrates, an entrenched beside perspective effect occurred, along with a modest situated perspective effect of task instructions. Consistent with an entrenched beside perspective, properties produced in both the beside and above groups were rated as more likely to be perceived from the beside perspective. In the participants analysis, the $P_i\Delta_{B-A}$ were significantly greater than 0 both for the beside group ($P_{\bar{x}}\Delta_{B-A} = 2.64$; $t(15) = 45.09$, SE = 0.06, $p < 0.0001$, $d = 11.27$) and for the above group ($P_{\bar{x}}\Delta_{B-A} = 2.45$; $t(15) = 33.30$, SE = 0.07, $p < 0.0001$, $d = 8.33$). In the concepts analysis, the $C_j\Delta_{B-A}$ were also significantly greater than 0 both for the above group ($t(6) = 14.89$, SE = 0.16, $p = 0.0001$, $d = 5.63$) and for the beside group ($t(6) = 14.74$, SE = 0.18, $p < 0.0001$, $d = 5.57$).

In support of a situated perspective effect, properties produced in the beside group were rated as having a somewhat greater beside perspective than properties produced in the above group. Specifically, the $P_i\Delta_{B-A}$ were significantly larger for the beside group than for the above group in the participants analysis ($P_{\overline{B-A}} = 0.19$; $t(30) = 2.02$, SE = 0.09, $p = 0.026$, $d = 0.71$) and were marginally larger in the concepts analysis ($t(6) = 1.66$, SE = 0.11, $p = 0.07$, $d = 0.63$).

Discussion

The results of Experiment 3 suggest the presence of an entrenched beside perspective during the representation of object concepts. In both the beside and above groups, the properties generated were more likely to be perceived from the beside perspective than from the above perspective. This effect suggests that participants tended to represent objects conceptually with properties perceived while beside them relative to being above them.

The presence of an entrenched beside perspective is consistent with the theoretical position that conceptual representations are grounded in action. Because people typically interact with objects that are beside them, it makes sense that people would tend to represent objects from this perspective.

A modest effect of situated task perspective also occurred. Adopting a beside vs. above task perspective somewhat modulated the strength of the entrenched beside perspective. Although an entrenched beside perspective dominated properties produced in both groups, the situated task perspective appeared to modulate this entrenched perspective modestly. In the "General Discussion", we offer a theoretical explanation for the first appearance of a situated perspective in this experiment.

Experiment 4: inside vs. outside

Experiment 4 assessed whether the representations of concepts differ when participants imagine being inside their referents vs. being outside them. The effects of task perspective (inside vs. outside) and rated perspective (inside vs. outside) were assessed on generated properties. Task perspective was manipulated by asking two different groups of participants to indicate whether they had ever been inside each object or outside it, where the critical objects were buildings and vehicles that participants had experienced from both perspectives (e.g. house, car). In each trial of the detection task, participants had to indicate whether the presented concept would be something that they might observe from their assigned perspective. In a third of these trials, participants also generated properties of the object. Rated perspective was manipulated by having an additional group of raters evaluate the properties produced by the participants across both task perspectives, rating how likely it would be to experience each property while being inside vs. outside the respective object.

Because we most often interact with building and vehicles from the inside, a grounded view of concepts predicts that the properties produced should exhibit an entrenched inside perspective, with inside properties generally being produced more often than outside properties across both conditions. Additionally, we predicted that this entrenched perspective effect would be modulated by the situated perspective that participants were asked to adopt during the detection task.

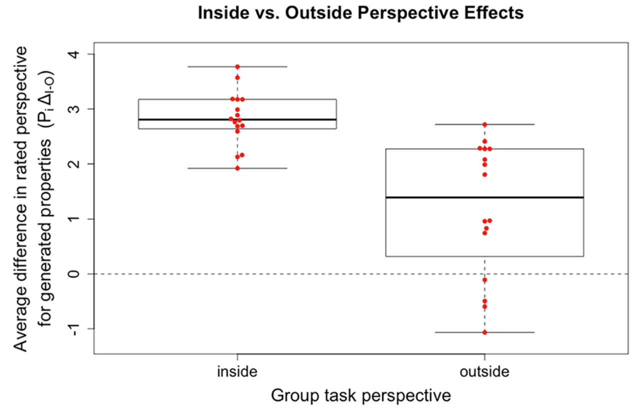

Fig. 5 Results from Experiment 4 showing overall difference scores, $P_i\Delta_{I-O}$, for properties generated by participants taking the inside task perspective (I) vs. the outside task perspective (O) (16 participants per group). $P_i\Delta_{I-O}$ represents the difference in rated likelihood of perceiving the properties generated in each group from the inside vs. outside perspectives

Method

Design and participants

The experiment used a mixed design with the between-participants variable of task perspective having two levels (inside vs. outside), and the within-participants variable of rated perspective also having two levels (inside vs. outside). Participants (32) and concepts (7) were included as random factors, with 16 participants randomly assigned to each task perspective. Participants were 32 students at the University of Chicago, all English native speakers. Participants were recruited on campus by an experimenter and volunteered for their participation, not receiving compensation.

Materials

Seven basic-level concepts were selected whose properties could vary if they are viewed from the inside vs. the outside. While the properties of elevators and chairs can be seen from inside a skyscraper, the properties of tall and antenna on top can be better seen from outside. The seven selected concepts were skyscraper, museum, car, house, airplane, bar, and prison. All could be viewed from the inside or outside. The critical concepts represented 1/3 of all the concepts presented, with the remaining 14 concepts being fillers. Of the 21 concepts, 11 can be experienced while being either inside or outside it (e.g. skyscraper, library, train), and 10 cannot (e.g. radio, needle, soup), with the former eliciting a 'yes' response on the detection task, the latter eliciting a 'no' response. Two random orders of the 21 concepts were constructed.

Procedure

The procedure was the same as in the previous experiments, except for the task perspective instructions. For the inside task perspective, participants were asked, "Have you ever been inside a church?" For the outside task perspective, participants were asked, "Have you ever been outside a church?" For every concept, participants responded 'yes' or 'no' to the relevant detection question. When subsequently probed on the critical trials, participants generated the concept's properties for 10 s.

Results

The concept norms, property ratings, and statistical analyses were analogous to those in Experiment 1, unless noted otherwise. The same judges who rated properties in the previous experiments also rated the properties generated in this experiment, except on different scales. Here, the judges were first asked, "Imagine you are inside/outside a [concept]". The judges then rated each property on a seven-point scale twice for: (1) How much would you experience the property if you were inside a [concept] (inside rated perspective)? (2) How much would you experience the property if you were outside a [concept] (outside rated perspective)? The mean correlation between the average ratings for the two perspectives was −0.35.

Figure 5 presents the critical results from Experiment 4. Although Fig. 5 only shows results from the participant analyses, the text presents results from both the participant and concept analyses. Table 1 presents the average number of properties that participants generated in each condition.

As described in the "Statistical Analysis" section, overall difference scores between ratings for the inside (I) and outside (O) perspectives were computed for participants and concepts ($P_i\Delta_{\text{I–O}}$, $C_j\Delta_{\text{I–O}}$) and submitted to t tests that assessed the directional hypotheses of interest. Table 2 presents the average perspective ratings for the individual conditions that underlie the difference scores.

As Fig. 5 illustrates, an entrenched inside perspective effect occurred, along with a strong situated perspective effect of task instructions. Consistent with an entrenched inside perspective, properties produced in both the inside and outside groups were rated as more likely to be perceived from the inside perspective. In the participants analysis, the $P_i\Delta_{\text{I–O}}$ were significantly greater than 0 both for the inside group ($P_{\bar{x}}\Delta_{\text{I–O}} = 2.83$; $t(15) = 22.82$, $\text{SE} = 0.12$, $p < 0.0001$, $d = 5.70$) and for the outside group ($P_{\bar{x}}\Delta_{\text{I–O}} = 1.19$; $t(15) = 3.90$, $\text{SE} = 0.31$, $p < 0.0005$, $d = 0.97$). In the concepts analysis, the $C_j\Delta_{\text{I–O}}$ were also significantly greater than 0 both for the inside group ($t(6) = 8.34$, $\text{SE} = 0.34$, $p < 0.0001$, $d = 3.15$) and for the outside group ($t(6) = 2.58$, $\text{SE} = 0.49$, $p = 0.021$, $d = 0.98$).

In support of a situated perspective effect, properties produced in the inside group were rated as having a greater inside perspective than properties produced in the outside group. Specifically, the $P_i\Delta_{\text{I–O}}$ were significantly larger for the inside group than for the outside group both in the participants analysis ($P_{\overline{\text{I–O}}} = 1.64$; $t(30) = 4.97$, $\text{SE} = 0.33$, $p < 0.0001$, $d = 1.76$) and in the concepts analysis ($t(6) = 4.70$, $\text{SE} = 0.33$, $p = 0.0015$, $d = 1.96$).

Discussion

The results of Experiment 4 suggest the presence of an entrenched inside perspective during the representation of building and vehicle concepts. In both the inside and outside groups, the properties generated were more likely to be perceived from the inside perspective than from the outside perspective. This effect suggests that participants tended to represent buildings and vehicles conceptually with properties perceived while being inside them relative to being outside.

The presence of an entrenched inside perspective is consistent with the theoretical position that conceptual representations are grounded in action. Because people typically interact with building and vehicles while inside them, it makes sense that people would tend to represent them from this perspective.

A strong effect of situated task perspective also occurred. Adopting an inside vs. outside task perspective modulated the strength of the entrenched inside perspective. Although an entrenched inside perspective dominated the properties produced in both groups, the situated task perspective strongly modulated this entrenched perspective as well. In the "General Discussion", we offer a theoretical explanation for the first strong appearance of a situated perspective.

Experiment 5: vision, audition, and touch

Experiment 5 assessed whether the representations of concepts differ when participants imagine experiencing their referents by seeing, hearing, or touching them. The effects of task perspective (vision, audition, touch) and rated perspective (vision, audition, touch) were assessed on generated properties. Task perspective was manipulated by asking three different groups of participants to imagine being in a backyard and seeing an object (vision), hearing it (audition), or throwing (and therefore touching) it. In each trial of the detection task, participants had to indicate whether the presented concept would be something that they might observe from their assigned perspective. In a third of these trials, participants also generated properties of the object. Rated perspective was manipulated by having an additional group of raters evaluate the properties produced by the participants across the three task perspectives, rating how likely it would be to experience each property with vision, audition, or touch.

Because vision is especially important while interacting with objects, and also touch during action, a grounded view of concepts predicts that the properties produced might exhibit entrenched perspectives for vision and/or touch, with visual and tactile properties generally being produced more often than auditory properties across both conditions. Additionally, we predicted that any entrenched perspective would be modulated by the situated perspective that participants were asked to adopt during the detection task.

Method

Design and participants

The experiment used a mixed design with the between-participants variable of task perspective having three levels (visual, auditory, touch), and the within-participants variable of rated perspective also having three levels (visual, auditory, touch). Participants (48) and concepts (9) were included as random factors, with 16 participants randomly assigned to each task perspective. Participants were 48 students at the University of Chicago, all English native speakers. Participants were recruited on campus by an experimenter and volunteered for their participation, not receiving compensation.

Materials

Nine basic-level concepts were selected that have visual, auditory, and tactile properties and that can be seen, heard, and touched (while being thrown) in a back yard. For example, the concept telephone has visual properties (e.g. black), auditory properties (e.g. rings), and tactile properties (e.g. smooth). The nine selected concepts were telephone, mud, flag, television, mosquito, compact disc, lawnmower, axe, and juice. All could be seen, heard, and touched (while being thrown) in a backyard. The critical concepts represented 1/3 of all the concepts presented, with the remaining 18 concepts being fillers. Of the 27 concepts, 13 could be seen/heard/touched (while being thrown) in a backyard (e.g. telephone, violin, radio), and 14 could not (e.g. skyscraper, ghost, mountain). Two random orders of the 27 concepts were constructed.

Procedure

The procedure was the same as in the previous experiments, except for the task perspective instructions. All three groups of participants were asked to imagine being in a backyard. Additionally, the vision group was asked whether it would be possible to see each object there; the audition group was asked if would be possible to hear each object there; and the touch group was asked if it would be possible to throw (and therefore touch) each object there. For every concept, participants responded 'yes' or 'no' to the relevant detection question. When subsequently probed on the critical trials, participants generated the concept's properties for 10 s.

Results

The concept norms, property ratings, and statistical analyses were analogous to those in Experiment 1, unless noted otherwise. The same judges who rated properties in the previous experiments also rated the properties generated in this experiment, except on different scales. Here, the judges were first asked, "Imagine that you are in a backyard and a [concept] is present." The judges then rated each property on a seven-point scale three times for: (1) How much would you experience the property visually if you encountered a [concept] in the back yard (visual rated perspective)? (2) How much would you experience the property auditorally if you encountered a [concept] in the back yard (auditory rated perspective)? (3) How much would you touch the property while throwing a [concept] in the back yard (touch rated perspective)? The mean correlation between the average ratings was 0.25 for vision and touch, − 0.21 for vision and audition, and − 0.14 for touch and audition.

Figure 6 presents the critical results from Experiment 5. Although Fig. 6 only shows results from the participant analyses, the text presents results from both the participant and concept analyses. Table 1 presents the average number of properties that participants generated in each condition.

As described in the "Statistical Analysis" section, overall difference scores between each pair ratings for the vision (V), touch (T), and audition (A) perspectives were computed for participants and concepts ($\mathrm{P_i}\Delta_{\mathrm{V-T}}$, $\mathrm{P_i}\Delta_{\mathrm{V-A}}$, $P_i\Delta_{\mathrm{T-A}}$, $C_j\Delta_{\mathrm{V-T}}$, $C_j\Delta_{\mathrm{V-A}}$, $C_j\Delta_{\mathrm{T-A}}$) and submitted to t tests that assessed the hypotheses of interest. In presenting the results, we will address one pairwise difference at a time: vision–touch (V–T), vision–audition (V–A), and touch–audition (T–A). In each case, we will assess the directional hypotheses that the first member of each pair (vision, and touch, respectively) exhibits an entrenched perspective effect, along with a situational task effect. Table 2 presents the average perspective ratings for the individual conditions that underlie the difference scores.

Vision–touch

First, consider the difference scores between the vision and touch task conditions, $P_i\Delta_{\mathrm{V-T}}$ and $C_j\Delta_{\mathrm{V-T}}$. As Fig. 6a illustrates, an entrenched effect of visual perspective occurred, along with a situated perspective effect of task instructions. Consistent with an entrenched visual perspective, properties produced in both the vision and touch groups were rated as more likely to be perceived from the visual perspective. In the participants analysis, the $\mathrm{P_i}\Delta_{\mathrm{V-T}}$ were significantly greater than 0 both for the vision group ($P_{\bar{x}}\Delta_{\mathrm{V-T}} = 1.41$; $t(15) = 32.15$, $\mathrm{SE} = 0.044$, $p < 0.0001$, $d = 8.04$) and for the touch group ($P_{\bar{x}}\Delta_{\mathrm{V-T}} = 1.07$; $t(15) = 19.16$, $\mathrm{SE} = 0.56$, $p < 0.0001$, $d = 4.79$). In the concepts analysis, the $C_j\Delta_{\mathrm{V-T}}$ were also significantly greater than 0 both for the vision group ($t(8) = 8.98$, $\mathrm{SE} = 0.16$, $p < 0.0001$, $d = 2.99$) and for the touch group ($t(8) = 4.81$, $\mathrm{SE} = 0.67$, $p < 0.0005$, $d = 1.60$).

In support of a situated perspective effect, properties produced in the vision group were rated as having a greater visual perspective than properties produced in the touch group. Specifically, the $P_i\Delta_{\mathrm{V-T}}$ were significantly larger for the vision group than for the touch group both in the participants analysis ($P_{\overline{V-T}} = 0.34$; $t(30) = 4.73$, $\mathrm{SE} = 0.07$, $p = 0.0001$, $d = 1.67$) and in the concepts analysis ($t(8) = 4.38$, $\mathrm{SE} = 0.078$, $p = 0.001$, $d = 1.46$).

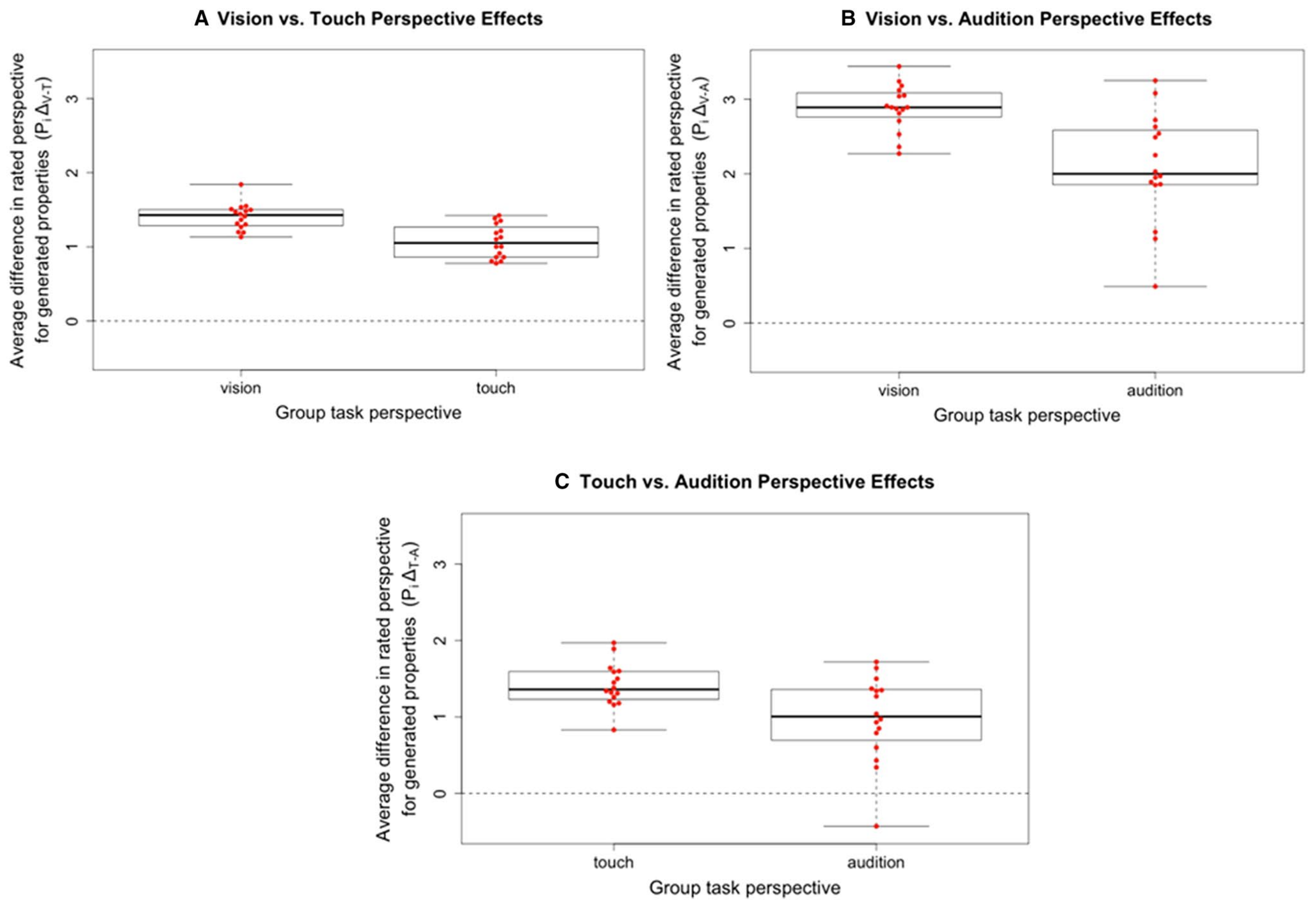

Fig. 6 Results from Experiment 5 showing overall difference scores for properties generated by participants taking the vision task perspective (V) vs. the touch task perspective (T) vs. the audition task perspective (A) (16 participants per group). **a** $P_i\Delta_{V\text{–}T}$ represents the difference in rated likelihood of perceiving the properties generated in the vision and touch groups from the vision vs. touch perspectives. **b** $P_i\Delta_{V\text{–}A}$ represents the difference in rated likelihood of perceiving the properties generated in the vision and audition groups from the vision vs. audition perspectives. **c** $P_i\Delta_{T\text{–}A}$ represent the difference in rated likelihood of perceiving the properties generated in the touch and audition groups from the touch vs. audition perspectives

Vision–audition

Next, consider the difference scores between the vision and audition task conditions, $P_i\Delta_{V\text{–}A}$ and $C_j\Delta_{V\text{–}A}$. As Fig. 6b illustrates, an entrenched effect of visual perspective occurred, along with a situated perspective effect of task instructions. Consistent with an entrenched visual perspective, properties produced in both the vision and audition groups were rated as more likely to be perceived from the visual perspective. In the participants analysis, the $P_i\Delta_{V\text{–}A}$ were significantly greater than 0 both for the vision group ($P_{\bar{x}}\Delta_{V\text{–}A}=2.89$; $t(15)=37.01$, $SE=0.32$, $p<0.0001$, $d=9.25$) and for the audition group ($P_{\bar{x}}\Delta_{V\text{–}A}=2.08$; $t(15)=11.52$, $SE=0.18$, $p<0.0001$, $d=2.88$). In the concepts analysis, the $C_j\Delta_{V\text{–}A}$ were also significantly greater than 0 both for the vision group ($t(8)=14.64$, $SE=0.20$, $p<0.0001$, $d=4.88$) and for the audition group ($t(8)=6.95$, $SE=0.90$, $p<0.0001$, $d=2.32$).

In support of a situated perspective effect, properties produced in the vision group were rated as having a greater visual perspective than properties produced in the audition group. Specifically, the $P_i\Delta_{V\text{–}A}$ were significantly larger for the vision group than for the touch group both in the participants analysis ($P_{\overline{V\text{–}A}}=0.80$; $t(30)=4.08$, $SE=0.19$, $p=0.0001$, $d=1.44$) and in the concepts analysis ($t(8)=5.93$, $SE=0.13$, $p=0.0001$, $d=1.98$).

Touch–audition

Finally, consider the difference scores between the touch and audition task conditions, $P_i\Delta_{T\text{–}A}$ and $C_j\Delta_{T\text{–}A}$. As Fig. 6c illustrates, an entrenched effect of touch perspective occurred, along with a situated perspective effect of task instructions. Consistent with an entrenched touch perspective, properties produced in both the touch and audition groups were rated as more likely to be perceived from the touch perspective. In the participants analysis, the $P_i\Delta_{T-A}$ were significantly greater than 0 both for the touch group ($P_{\bar{x}}\Delta_{T-A}=1.41$; $t(15)=19.83$, $SE=0.71$, $p<0.0001$, $d=4.96$) and for the audition group ($P_{\bar{x}}\Delta_{T-A}=0.98$; $t(15)=7.06$, $SE=0.14$, $p<0.0001$, $d=1.76$). In the concepts analysis, the $C_j\Delta_{T-A}$ were also significantly greater than 0 both for the touch group ($t(8)=4.99$, $SE=0.28$, $p<0.0005$, $d=1.67$) and for the audition group ($t(8)=3.120$, $SE=0.31$, $p=0.005$, $d=1.04$).

In support of a situated perspective effect, properties produced in the touch group were rated as having a greater visual perspective than properties produced in the audition group. Specifically, the $P_i\Delta_{T-A}$ were significantly larger for the touch group than for the audition group both in the participants analysis ($P_{\overline{T-A}}=0.43$; $t(30)=2.76$, $SE=0.16$, $p=0.005$, $d=0.98$) and in the concepts analysis ($t(8)=4.74$, $SE=0.091$, $p<0.0005$, $d=1.58$).

Discussion

The results of Experiment 5 suggest the presence of entrenched perspectives for vision and touch during the representation of concepts. Across the vision, touch, and audition groups, the properties generated were most likely to be perceived from the visual perspective, next most likely to be perceived from the tactile perspective, and least likely to be perceived from the auditory perspective. This pattern suggests that participants tended to represent objects conceptually with properties perceived while visually viewing and physically interacting with them.

The presence of entrenched visual and tactile perspectives is consistent with the theoretical position that conceptual representations are grounded in action. Because people often perceive objects visually and tactilely with interacting them, it makes sense that people would tend to represent them from these perspectives.

Strong effects of situated task perspective also occurred. Adopting visual, tactile, and auditory task perspectives strongly modulated the strength of the entrenched visual and tactile perspectives. Although entrenched visual and touch perspectives dominated the properties produced across the three groups, the situated task perspectives strongly modulated these entrenched perspectives as well. In the "General Discussion", we attempt to integrate these situated task perspectives across experiments.

General discussion

Summary of results

Consistent with the grounded view of cognition, conceptualizations of categories have perspectives that reflect important perspectives in situated action: facing the fronts of nearby approaching entities, processing entities visually, and being inside large objects such as houses and cars. Similar to how perceptions always have perspectives, so do conceptualizations. Across all experiments, the properties produced for concepts reflected entrenched and/or task perspectives, ruling out the null hypothesis that concepts are not represented from particular perspectives. Importantly, the results hold for both spatial perspective (Experiments 1–4) and for sensory perspectives (Experiment 5).

Our results also allowed us to rule out the demand hypothesis, according to which participants believe that they should produce features from the perspective adopted in the detection task. The demand hypothesis predicted only situation-dependent effects, but we found evidence of both entrenched and situational perspectives. The presence of entrenched effects across all experiments indicates that the task was not transparent to participants. The lack of situated effects in Experiments 1 and 2 further argues against demand effects, given that the demand hypothesis predicts situation effects in all experiments.

Entrenchment effects

A robust entrenchment effect reflecting an important perspective for situated action was observed in every experiment. In Experiment 1, we found an entrenched toward perspective, indicating that participants tended to represent entities (e.g. train, woman) from the front rather than from the back. In Experiment 2, we found an entrenched near perspective, indicating that participants tended to represent entities close rather than far away. In Experiment 3, we found an entrenched beside perspective, indicating that participants tended to represent entities near beside them than far above them. In Experiment 4, we found an entrenched inside perspective, indicating that participants tended to represent buildings and vehicles from the inside than from the outside. Finally, Experiment 5 revealed entrenched perspectives for both vision and action, indicating that participants tended to represent entities more visually than tactilely, more tactilely than auditorally. The ubiquitous robust presence of entrenched perspectives across experiments suggests that concepts are grounded in situated action: We tend to interact with entities that are in front of us, beside us and close by, seeing and touching them.

One could ask whether entrenchment effects are the results of conceptual cores (Lebois, Wilson-Mendenhall and Barsalou, 2015), namely, properties that necessarily characterize concepts. We do not think that entrenched effects imply the need for conceptual cores; such effects could instead simply be the result of statistical co-occurrence between features. Entrenchment effects are consistent with the grounded perspective, which proposes that simulations play central roles in representing concepts. When simulations represent concepts, then a perspective must always be present (as in perception). It is difficult if not impossible to imagine a perspectiveless simulation. Indeed, our original prediction that conceptual representations would exhibit perspective effects followed from adopting the grounded perspective. From this perspective, one would expect to see perspective playing important roles in conceptual processing, which appears to be the case. Whatever simulation is constructed to represent a category renders some properties of the simulated entity more easily accessible than others, with these properties often being relevant for situated action.

Situational effects

We also observed evidence of task-specific situational perspectives in conceptual processing. Unlike entrenchment effects that occurred in every experiment, situational effects were not always present. Only in Experiment 3 (beside–above), Experiment 4 (inside–outside), and Experiment 5 (vision–touch–audition) did we observe effects of the task perspective that participants adopted. In Experiment 3, participants exhibited a moderate effect of adopting the beside vs. above task perspective, which modulated the stronger entrenched beside perspective. In Experiment 4, participants exhibited a strong effect of adopting the inside vs. outside task perspective that combined with a still stronger entrenched inside perspective. This patterns suggests that it was quite easy to simulate being outside an object or place, without necessarily reverting to an inside perspective. Finally, in Experiment 5, a strong task perspective modulated the entrenched vision–touch perspective effect, revealing that it was easy to simulate listening to the sound of an entity rather than seeing/interacting with it.

Overall, the powerful effects of entrenched perspectives, together with the relative difficulty of adopting situational perspectives, indicates that entities are largely conceptualized in terms of the more frequent actions we typically perform with them (see Borghi and Riggio, 2009; Palmer, Rosch and Chase, 1981). In Bayesian terms, one could argue that the a priori predictions we form based on previous experience ("priors") are dominant over "likelihoods" that reflect relevant task information in the current situation (Friston, 2010; Tenenbaum, Griffiths, and Kemp, 2006). Even though the task perspective might induce participants to imagine pizza at a distance, for example, participants often revert to the default perspective, zooming in and representing the pizza close to them, as when they eat it. At the same time, the role played by situational perspective highlights the flexibility of the cognitive system to support action in a sophisticated way, accessing different information when taking different perspectives, depending on the current goals and situation (Lebois, et al., 2015).

While the results of our study are quite clear, further research should address the issue of perspective and of the interplay between entrenched and situational perspectives with different paradigms. For example, it would be important to investigate response times in addressing interactions between these two kinds of perspective (see Borghi, Glenberg and Kaschak, 2004; Estes and Barsalou, 2018), time courses of activation for the different perspectives, and the neural underpinnings of the different perspectives. Finally, notice that this study was conducted before pre-registration existed. The hypotheses stated in our manuscript were the original ones that we began with, and they were not changed or altered after the results were known (harking). However, we think it is important that further studies on this topic should be conducted using pre-registrations or registered report formats.

Open issues

Explaining simultaneous entrenched and situational perspectives

How do participants simultaneously adopt an entrenched perspective and an apparently conflicting situational perspective in a given task? One possibility is that participants form a simulation driven by the task perspective, but then revert to the dominant entrenched perspective. The stronger the priors formed on the basis of previous situated actions, the stronger role that the entrenched perspective has, and the earlier it re-emerges.

Explaining the varying strength of situational perspectives

A second issue concerns what causes situational perspective effects not to emerge in some situations but to appear in others. Why did we find no situational perspective effect in Experiments 1 and 2, a moderate situational effect in Experiment 3, and strong situational effects in Experiments 4 and 5? The strength of the correlation between the two perspectives appears to offer a good explanation: The more different the two perspectives are, the more potential the detection manipulation has to influence the properties represented and subsequently generated.

Figure 7 illustrates this relationship. The *X* axis of Fig. 7 plots the correlation for how likely an entity's properties are perceived from each of the two perspectives in an experiment (as rated by the six judges, with Experiment 5 having three pairs of perspectives and the other four experiments each having one). When the judges' rated likelihood of perceiving a property was generally the same from both perspectives, these correlations were high; when the rated likelihoods of perceiving a property varied considerably between perspectives, the correlation was low. The *Y* axis

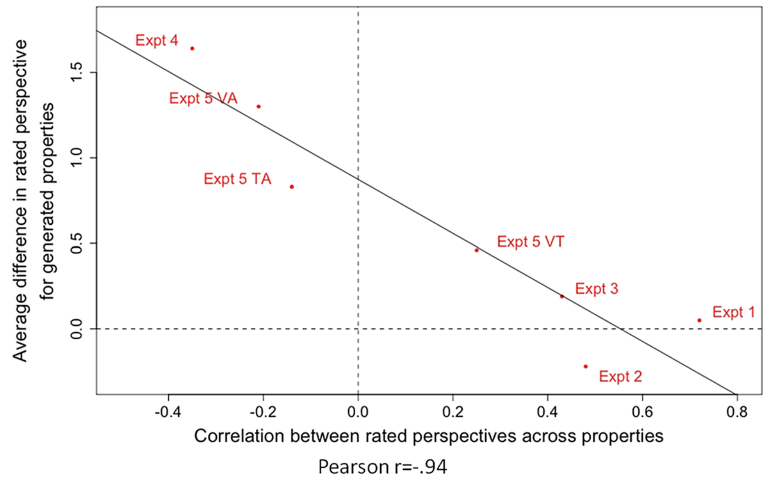

Fig. 7 The relationship between how much generated properties differed in perspective between the respective task conditions (*Y* axis) and how similarly properties were perceived across the two perspectives (*X* axis). For Experiments 1, 2, 3, and 4, one point represents the two perspectives examined in it. For Experiment 5, three points represent each pair of perspectives between vision, touch, and audition. See the text for how the specific measures were calculated. The seven data points in the figure exhibit a −0.94 Pearson correlation ($df=5$, $p<0.01$, two-tailed)

of Fig. 7 plots how much each pair of perspectives was influenced by the task (i.e. how much the properties generated in each task condition differed on the rated perspectives; $P_i\mathrm{D}_{X-Y}$ where *X* and *Y* represent the two perspectives). The higher the *Y* value, the more the two task conditions differed in the perspective of the properties generated.

First consider the point for Experiment 1 in Fig. 7. The two rated perspectives of the overall property set barely differed, with the likelihood of perceiving a property from the toward and away perspectives generally being similar (i.e. the correlation between the judges' ratings for perceiving the properties from each perspective was 0.72). Correspondingly, the features generated in each task condition barely differed in their rated perspectives, with both showing an equally strong bias towards the toward perspective (i.e. the difference between task conditions was only 0.05). In contrast, consider the point for Experiment 4 in this plot. The rated perspectives of the generated properties differed considerably, with some more likely to be experienced from the inside of the respective object, and others more likely to be experienced from the outside (thus, the correlation between the judges' ratings for perceiving the properties from each perspective was −0.35). Correspondingly, the features generated in each task condition differed considerably in their rated perspectives, with the properties generated during the inside task reflecting a much stronger inside bias than properties generated during the outside task (i.e. the difference between task conditions was 1.64).

Other points in Fig. 7 between the two points just described generally show a strong negative relationship between how similarly properties were perceived from across the two rated perspectives, and how much generated properties differed in perspective between the respective task conditions. Overall, the Pearson R for this approximately linear relationship was −0.94. Even with only seven data points, this correlation was statistically significant (5 *df*, $p<0.01$, two-tailed).

Interestingly, Experiments 2 and 3 had about the same correlation between rated perspectives, but the generation difference was larger in Experiment 3. Speculatively, this pattern can be explained by the fact that situated action for beside vs. above is likely to differ more than it does for near vs. far. Hence, exploring the role of situated action in conceptualization is informative for better understanding how properties become salient from different perspectives.

Parallel representations

The interplay between entrenched and situational perspectives and their simultaneous activation might be explained by some kind of parallel representation. Analogous cases are found in studies on negation and on colour. For example, when we read "There is no eagle in the sky" we activate the image of the referent, but at the same time we mentally delete it (Kaup and Zwaan, 2003); analogously, in unusual contexts people seem to represent in parallel both the typical object colour and the colour specifically activated by the current situation. (Connell and Lynott, 2009). Further research is needed to understand the mechanisms underlying the activation of these parallel representations. Quantum cognition offers a potential approach for accommodating parallel representations of different but compatible perspectives (e.g. Bruza, Want, and Busemeyer, 2015).

Multiple representations

Our experiments clearly demonstrate that conceptual representations include perspectives, consistent with the use of simulations to represent categories. It remains unclear, however, whether we store just one general representation for each entity that is changed and transformed according to different perspectives, or whether multiple entity representations are stored, one for each perspective. In other words, do we represent an abstract, prototypical "car" that we eventually transform depending on the adopted perspective, or do we separately represent cars perceived from different perspectives (from the front, from the back, etc.)? This difficult problem continues to challenge modern research, much as it has in a long-lasting debate between defenders of prototype and exemplar models (e.g. Biederman and Gerhardstein, 1993; Tarr and Bülthoff, 1995). Defenders of a strong exemplar view predict storage of one separate entity representation for each perspective. The presence of common properties produced across perspectives does not help solve the problem, because each representation of an entity from different perspectives could contain copies of the same property.

Semantic associations

Although our results are consistent with the simulation view, they can also be explained as the result of word associations, for example, as in latent semantic analysis (LSA; Landauer and Dumais, 1997). Following LSA, the perspective effects we found could be due to semantic associations between task instructions to adopt a particular perspective and the produced properties. Because we used a feature generation task, it is impossible to determine with certainty to what extent the perspective effect depends on simulation, and to what extent it simply reflects semantic associations between words. A lot of evidence exhibits that semantic associates affect conceptual processing, and their role in our perspective paradigm remains to be established (e.g. Andrews, Frank, Vigliocco, 2014; Barsalou, Santos, Simmons, and Wilson, 2008; Louwerse, and Connell, 2011). Even if semantic associates turn out to be important, it is likely that they become established as the result of situated action and that they are integrated with accompanying simulations. Whether our results depend solely on simulation or on linguistic associations, we believe it is in any case interesting that they reflect both an entrenched and a situated perspective. More generally, we think that word associations are central to conceptual processing, and we are quite sympathetic to views that assign an important role to linguistic experience. Language contributes to establishing rich semantic networks, and words can chunk sensory inputs in novel and productive ways (Lupyan, 2019).

A related issue concerns how distributional approaches alone, without simulation, would attempt to explain the interplay between entrenched perspectives, formed on the basis of long-term linguistic associations between the concept and frequent actions, and situational perspectives, formed online while associating the target word with the perspective induced by task instructions. Finally, even if amodal approaches rather than grounded ones turn out to be the best account of these results, it would be important and useful to know how they handle the constant interplay between entrenched and situational perspectives.

In general, our results demonstrate the strong presence of entrenched perspectives sometimes modulated by task perspective. All views, including simulation and semantic association, must explain this pattern of results. Although the simulation view motivated the prediction of this pattern a priori, stronger evidence for simulation is required before concluding that this kind of mechanism underlies our observed perspective effects.

Construal level theory

Our results seem to have interesting implications for theories such as the construal level theory (CLT; Liberman and Troope, 2014). According to CLT, distance increases the abstraction level of representations; hence, spatial distance increases global perception rather than perception of details. Our results might apparently seem in conflict with the claims of CLT, since they show that our representation of distance is flexible and not dichotomous: hence, when we are invited to imagine objects/locations at a distance we tend to represent them as close to us, focusing on their details. It is possible that such flexibility is characteristic of the way we represent distance, but not necessarily of the way we perceive distance: we might perceive far away objects as more abstract than near objects, but we might represent far away objects as rich in details, similarly to close objects. This distinction between perceived distance and represented distance should be accounted for by the CLT theory.

Conclusion

Grounded cognition views predict that because perceptions have perspectives, conceptualizations should have perspectives as well. Indeed, it is difficult to imagine a simulation without a perspective. Results across five experiments clearly confirm that conceptualizations contain both entrenched and situational perspectives, suggesting further that dominant perspectives are grounded in situated action. While entrenched perspectives emerge from canonical actions we typically perform with objects, locations and entities, situational perspectives reflect online adaptations to current task contexts. The interplay between entrenched and situational perspectives sheds light on both the situated character of conceptual processing and the exquisite flexibility it exhibits.

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Compliance with ethical standards

Conflict of interest Both authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee.

References

Abelson, R. P. (1975). Does a story understander need a point of view? In *Proceedings of the 1975 workshop on Theoretical issues in natural language processing* (pp. 140–143). Association for Computational Linguistics.

Anderson, R. C., & Pichert, J. W. (1978). Recall of previously unrecallable information following a shift in perspective. *Journal of verbal learning and verbal behavior, 17*(1), 1–12.

Andrews, M., Frank, S., & Vigliocco, G. (2014). Reconciling embodied and distributional accounts of meaning in language. *Topics in Cognitive Science, 6*(3), 359–370.

Barsalou, L. W. (1999). Perceptual symbol systems. *Behavioral and Brain Sciences, 22,* 577–609.

Barsalou, L. W. (2008). Grounded cognition. *Annual Review of Psychology, 59,* 617–645.

Barsalou, L. W. (2016). On staying grounded and avoiding quixotic dead ends. *Psychonomic Bulletin & Review, 23*(4), 1122–1142.

Barsalou, L. W., Santos, A., Simmons, W. K., & Wilson, C. D. (2008). Language and simulation in conceptual processing. In M. De Vega, A. M. Glenberg, & A. C. Graesser (Eds.), *Symbols, embodiment, and meaning* (pp. 245–283). Oxford: Oxford University Press.

Barsalou, L. W., Simmons, W. K., Barbey, A. K., & Wilson, C. D. (2003). Grounding conceptual knowledge in modality-specific systems. *Trends in Cognitive Sciences, 7,* 84–91.

Beveridge, M. E., & Pickering, M. J. (2013). Perspective taking in language: integrating the spatial and action domains. *Frontiers in human neuroscience, 7,* 577.

Biederman, I., & Gerhardstein, P. C. (1993). Recognizing depth-rotated objects: evidence and conditions for three-dimensional viewpoint invariance. *Journal of Experimental Psychology: Human perception and performance, 19*(6), 1162.

Black, J. B., Turner, T. J., & Bower, G. H. (1979). Point of view in narrative comprehension, memory, and production. *Journal of Verbal Learning and Verbal Behavior, 18*(2), 187–198.

Borghi, A. M., & Caruana, F. (2015). Embodiment Theory. In J. D. Wright (Ed.), *International encyclopedia of the social & behavioral sciences* (2nd ed., Vol. 7, pp. 420–426). Oxford: Elsevier.

Borghi, A. M., Glenberg, A. M., & Kaschak, M. P. (2004). Putting words in perspective. *Memory & Cognition, 32*(6), 863–873.

Borghi, A. M., & Riggio, L. (2009). Sentence comprehension and simulation of objects temporary, canonical and stable affordances. *Brain Research, 1253,* 117–128.

Brunyé, T. T., Ditman, T., Mahoney, C. R., Augustyn, J. S., & Taylor, H. A. (2009). When you and I share perspectives pronouns modulate perspective taking during narrative comprehension. *Psychological Science, 20*(1), 27–32.

Bruza, P. D., Wang, Z., & Busemeyer, J. R. (2015). Quantum cognition: A new theoretical approach to psychology. *Trends in Cognitive Sciences, 19,* 383–393.

Bruzzo, A., Borghi, A. M., & Ghirlanda, S. (2008). Hand–object interaction in perspective. *Neuroscience Letters, 441*(1), 61–65.

Connell, L., & Lynott, D. (2009). Is a bear white in the woods? Parallel representation of implied object color during language comprehension. *Psychonomic Bulletin & Review, 16*(3), 573–577.

Coventry, K. R., Griffiths, D., & Hamilton, C. J. (2014). Spatial demonstratives and perceptual space: Describing and remembering object location. *Cognitive Psychology, 69,* 46–70.

Coventry, K. R., Valdés, B., Castillo, A., & Guijarro-Fuentes, P. (2008). Language within your reach: Near–far perceptual space and spatial demonstratives. *Cognition, 108*(3), 889–895.

Diessel, H. (2006). Demonstratives, joint attention, and the emergence of grammar. *Cognitive linguistics, 17*(4), 463–489.

Ditman, T., Brunyé, T. T., Mahoney, C. R., & Taylor, H. (2010). Simulating an enactment effect: pronouns guide action simulation during narrative comprehension. *Cognition, 115,* 172–178. https://doi.org/10.1016/j.cognition.2009.10.014.

Duran, N. D., Dale, R., & Kreuz, R. J. (2011). Listeners invest in an assumed other's perspective despite cognitive cost. *Cognition, 121,* 22–40. https://doi.org/10.1016/j.cognition.2011.06.009.

Estes, Z., & Barsalou, L. W. (2018). A Comprehensive Meta-Analysis of Spatial Interference From Linguistic Cues: Beyond Petrova et al. (2018). *Psychological Science, 29*(9), 1558–1564.

Friston, K. (2010). The free-energy principle: a unified brain theory? *Nature reviews neuroscience*, *11*(2), 127.

Galati, A., & Avraamides, M. N. (2013). Flexible spatial perspective-taking: conversational partners weigh multiple cues in collaborative tasks. *Frontiers in Human Neuroscience, 7,* 618.

Gallese, V. (2009). Motor abstraction: A neuroscientific account of how action goals and intentions are mapped and understood. *Psychological Research PRPF, 73*(4), 486–498.

Gallese, V., & Lakoff, G. (2005). The brain's concepts: The role of the sensorimotor system in conceptual knowledge. *Cognitive Neuropsychology, 21,* 455–479.

Gianelli, C., Farnè, A., Salemme, R., Jeannerod, M., & Roy, A. C. (2011). The agent is right: when motor embodied cognition is space-dependent. *PLoS One, 23,* e25036.

Gianelli, C., Marzocchi, M., & Borghi, A. M. (2017). Grasping the agent's perspective: A kinematics investigation of linguistic perspective in Italian and German. *Frontiers in Psychology, 8,* 42. https://doi.org/10.3389/fpsyg.2017.00042.

Gianelli, C., Scorolli, C., & Borghi, A. M. (2013). Acting in perspective: The role of body and language as social tools. *Psychological Research, 77*(1), 40–52.

Glenberg, A. M. (2015). Few believe the world is flat: How embodiment is changing the scientific understanding of cognition. *Canadian Journal of Experimental Psychology/Revue Canadienne de Psychologie Expérimentale, 69*(2), 165.

Glenberg, A. M., Witt, J. K., & Metcalfe, J. (2013). From the revolution to embodiment: 25 years of cognitive psychology. *Perspectives on Psychological Science, 8,* 573–585.

Hamilton, A. F. D. C., Kessler, K., & Creem-Regehr, S. H. (2014). Perspective taking: building a neurocognitive framework for integrating the "social" and the "spatial". *Frontiers in human neuroscience, 8,* 403.

Harpaintner, M., Trumpp, N. M., & Kiefer, M. (2018). The semantic content of abstract concepts: A property listing study of 296 abstract words. *Frontiers in Psychology, 9,* 1748. https://doi.org/10.3389/fpsyg.2018.01748

Jackson, P. L., Meltzoff, A. N., & Decety, J. (2006). Neural circuits involved in imitation and perspective-taking. *Neuroimage, 31*(1), 429–439.

Kaup, B., & Zwaan, R. A. (2003). Effects of negation and situational presence on the accessibility of text information. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 29*(3), 439.

Kessler, K., & Rutherford, H. (2010). The two forms of visuo-spatial perspective taking are differently embodied and subserve different spatial prepositions. *Frontiers in Psychology*. https://doi.org/10.3389/fpsyg.2010.00213. **(Special Issue on: "Embodied and Grounded Cognition")**.

Landauer, T. K., & Dumais, S. T. (1997). A solution to Plato's problem: The latent semantic analysis theory of acquisition, induction, and representation of knowledge. *Psychological Review, 104,* 211–240.

Lebois, L. A., Wilson-Mendenhall, C. D., & Barsalou, L. W. (2015). Are automatic conceptual cores the gold standard of semantic processing? The context-dependence of spatial meaning in grounded congruency effects. *Cognitive Science, 39*(8), 1764–1801.

Leung, A. K.-Y., & Cohen, D. (2007). The soft embodiment of culture: Camera angles and motion through time and space. *Psychological Science, 18*(9), 824–830.

Levinson, S. C. (1996). Frames of reference and Molyneux's question: Crosslinguistic evidence. *Language and Space, 109,* 169.

Levinson, S. C. (2003). *Space in language and cognition: explorations in cognitive Diversity*. Cambridge, MA: Cambridge University Press.

Liberman, N., & Trope, Y. (2014). Traversing psychological distance. *Trends in Cognitive Sciences, 18*(7), 364–369.

Louwerse, M., & Connell, L. (2011). A taste of words: Linguistic context and perceptual simulation predict the modality of words. *Cognitive Science, 35*(2), 381–398.

Lupyan, G. (2019). Language as a source of abstract concepts: Comment on "Words as social tools: Language, sociality and inner grounding in abstract concepts" by Anna M. Borghi et al. *Physics of Life Reviews, 29,* 154–156. https://doi.org/10.1016/j.plrev.2019.05.001.

MacWhinney, B. (2005). The emergence of grammar from perspective. In D. Pecher & R. A. Zwaan (Eds.), *Grounding cognition: The role of perception and action in memory, language, and thinking*. Cambridge: Cambridge University Press.

Maeda, F., Kleiner-Fisman, G., & Pascual-Leone, A. (2002). Motor facilitation while observing hand actions: specificity of the effect and role of observer's orientation. *Journal of Neurophysiology, 87*(3), 1329–1335.

Martin, A. (2007). The representation of object concepts in the brain. *Annual Review of Psychology, 58,* 25–45.

Matheson, H. E., & Barsalou, L. W. (2018). Embodiment and grounding in cognitive neuroscience. In J. Wixted, E. Phelps, L. Davachi, J. Serences, S. Ghetti, S. Thompson-Schill, & E. J. Wagenmakers (Eds.), *The Stevens' Handbook of experimental psychology and cognitive neuroscience* (4th ed., Vol. 3, pp. 1–32). Hoboken, NJ: Wiley.

McRae, K., Cree, G. S., Seidenberg, M. S., & McNorgan, C. (2005). Semantic feature production norms for a large set of living and nonliving things. *Behavior Research Methods, 37*(4), 547–559.

Murphy, G. (2004). *The big book of concepts*. Cambridge: MIT press.

Palmer, S., Rosch, E., & Chase, P. (1981). Canonical perspective and the perception of objects. In J. Long & A. Baddeley (Eds.), *Attention and performance IX*. Hillsdale: Erlbaum.

Papeo, L., Corradi-Dell'Acqua, C., & Rumiati, R. I. (2011). "She" is not like "I": the tie between language and action is in our imagination. *Journal of cognitive neuroscience, 23*(12), 3939–3948.

Papies, E. K. (2013). Tempting food words activate eating simulations. *Frontiers in Psychology, 4,* 838.

Pecher, D., Zeelenberg, R., & Barsalou, L. W. (2003). Verifying different-modality properties for concepts produces switching costs. *Psychological Science, 14*(2), 119–124.

Posner, M. I., & Snyder, C. R. R. (1975). Attention and cognitive control. In R. L. Solso (Ed.), *Information processing and cognition* (pp. 205–223). Hillsdale, NJ: Lawrence Erlbaum Associates.

Saxe, R., Jamal, N., & Powell, L. (2005). My body or yours? The effect of visual perspective on cortical body representations. *Cerebral Cortex, 16*(2), 178–182.

Spivey, M. J., & Geng, J. J. (2001). Oculomotor mechanisms activated by imagery and memory: Eye movements to absent objects. *Psychological Research, 65*(4), 235–241.

Tarr, M. J., & Bülthoff, H. H. (1995). Is human object recognition better described by geon structural descriptions or by multiple views? Comment on Biederman and Gerhardstein (1993). *Journal of Experimental Psychology: Human Perception and Performance*, *21*, 6.

Tenenbaum, J. B., Griffiths, T. L., & Kemp, C. (2006). Theory-based Bayesian models of inductive learning and reasoning. *Trends in Cognitive Sciences, 10*(7), 309–318.

Tversky, B., & Hard, B. M. (2009). Embodied and disembodied cognition: Spatial perspective-taking. *Cognition, 110*(1), 124–129.

Vanoverberghe, V., & Storms, G. (2003). Feature importance in feature generation and typicality rating. *European Journal of Cognitive Psychology, 15*(1), 1–18.

Vogt, S., Taylor, P., & Hopkins, B. (2003). Visuomotor priming by pictures of hand postures: Perspective matters. *Neuropsychologia, 41*(8), 941–951.

Wilson, M. (2002). Six views of embodied cognition. *Psychonomic Bulletin & Review, 9*(4), 625–636.

Wu, S., Barr, D. J., Gann, T. M., & Keysar, B. (2013). How culture influences perspective taking: differences in correction, not integration. *Frontiers in human neuroscience, 7,* 822.

Wu, L. L., & Barsalou, L. W. (2009). Perceptual simulation in conceptual combination: Evidence from property generation. *Acta psychologica, 132*(2), 173–189.

Wu, S., & Keysar, B. (2007). The effect of culture on perspective taking. *Psychological Science, 18*(7), 600–606.

Yoon, S. O., Koh, S., & Brown-Schmidt, S. (2012). Influence of perspective and goals on reference production in conversation. *Psychonomic Bulletin & Review, 19,* 699–707. https://doi.org/10.3758/s13423-012-0262-6.