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Mapping Verb Meaning in Space: Spatial Feature Norms for Rioplatense Spanish Verbs

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Abstract

Understanding how language recruits spatial cognition to represent events and actions is central to theories of embodied cognition and cognitive linguistics. This study presents a normative dataset of spatial feature ratings for 75 verbs in Rioplatense Spanish, examining the relationship between image-schematic representations and syntactic congruence. A total of 639 native speakers completed an online Spatial Features Questionnaire for Verbal Semantics. Participants judged whether trajectory-based image schemas matched each verb under congruent (subject–verb–object) and incongruent (object–verb–subject) conditions. Chi-square analyses and proportion tests revealed higher acceptance rates for congruent configurations, indicating that syntactic order constrains spatial representations. Item-level analyses showed that a subset of verbs elicited stable spatial trajectory preferences under congruent conditions. These results provide a normative resource that characterizes structured verb–space associations and documents the role of syntactic structure in shaping spatial judgments, offering stimuli for future experimental and cross-linguistic research on embodiment and spatial grounding in Spanish verb processing.

Keywords: image schemas; embodied cognition; verb semantics; spatial representation; Rioplatense Spanish; syntactic congruence.

Introduction

Spatial cognition plays a fundamental role in how humans perceive, act upon, and conceptualize the world. From early sensorimotor experience, spatial information provides a foundational scaffold for memory, reasoning, and communication. Developmental research shows that spatial representations emerge early in childhood and play a central role in the acquisition of conceptual structure and language (Liben, 2005; Newcombe, 2018). From this perspective, image schemas are understood as pre-verbal structures acquired through recurrent sensorimotor interactions, which constitute foundational building blocks for conceptual development, language, and reasoning (Mandler, 2004). In adulthood, spatial cognition continues to support reasoning, discourse organization, and the construction of situation models, shaping how events and relations are mentally represented (Tversky, 2005; Wooding & Winter, 2018).

Within theories of embodied cognition and cognitive linguistics, these recurring spatial patterns are formalized as image schemas that link perception, action, and conceptualization, providing the basis for linguistic meaning (Lakoff & Johnson, 1980; Johnson, 1987; Barsalou, 1999). Because image schemas are particularly well suited to structure dynamic interactions with the world, they are especially relevant for the semantic representation of events and actions.

Against this background, verbs provide a key domain for examining image-schematic structure in meaning. As lexicalizations of events or happenings unfolding in time (de Almeida, 2015), verbs encode actions, relations, and states, making them particularly well suited to reveal how linguistic meaning recruits perceptual and motor systems. Action verbs, for instance, activate sensorimotor cortices associated with the relevant body effectors, including somatotopically organized motor regions (Hauk et al., 2004; Pulvermüller, 2005; García & Ibáñez, 2016), while visual verbs can modulate perceptual processes such as pupil dilation (Orenes et al., 2025). Together, these findings support a multimodal view of conceptualization, in which linguistic meaning emerges from the interaction between abstract representations and embodied simulation mechanisms. Image schemas—such as container, path, and link—provide fundamental templates for structuring both concrete and abstract domains, with evidence showing that even abstract concepts rely on spatial mappings grounded in perceptual experience (Boroditsky, 2000; Casasanto, 2009; Lakens, 2012).

If image schemas constitute shared organizing principles of meaning, a key empirical challenge is to capture these representations in a systematic and comparable way across speakers. A productive approach to addressing this challenge has been the use of norming studies, which allow researchers to identify shared conceptual patterns and provide standardized descriptions of semantic representations. Normative methodologies have played a central role in the empirical investigation of lexical meaning by characterizing lexical-semantic properties such as concreteness, imageability, sensorimotor associations, and affective dimensions, thereby supporting experimental

control and cross-study comparability (Paivio et al., 1968; Bradley & Lang, 1999; Binder et al., 2005, 2016).

Within the domain of embodied and cognitive linguistics, norming studies have been particularly valuable for examining how perceptual and motor information contributes to meaning construction, offering an empirical bridge between theoretical models of grounded cognition and experimental investigation (Barsalou, 1999; Vigliocco et al., 2011). In this tradition, semantic representations have been systematically characterized through ratings of semantic features and sensorimotor dimensions, capturing both shared conceptual attributes and modality-specific or effector-related grounding (McRae et al., 2005; Lynott & Connell, 2009, 2013; Binder et al., 2016; Vivas et al., 2017). Beyond their methodological contribution, these approaches have also advanced a conceptual view of semantic knowledge as graded and continuous rather than categorical. From this perspective, abstract and concrete meanings are not qualitatively distinct classes, but occupy different positions along a continuum shaped by experiential, perceptual, and action-related dimensions, reflecting systematic variation in their sensorimotor grounding (Borghi et al., 2017). This graded view provides the conceptual backdrop for examining specific experiential dimensions of meaning, among which spatial structure could play a particular role in organizing event representations.

Spatial image schemas in verb semantics: experimental and normative evidence

Early evidence for the spatial grounding of verb meaning comes from experimental studies of online language comprehension. Using sentence–picture verification and spatial compatibility paradigms, Richardson et al. (2001) and De Vega and Moreno (2006) showed that processing motion verbs activates directional spatial representations, supporting the view that verb meaning involves online spatial simulation.

Complementing this work, normative approaches have examined whether such representations are shared across speakers. Meteyard and Vigliocco (2009) developed spatial feature norms for English verbs, revealing stable patterns of agreement and confirming that trajectory-based image schemas constitute a reliable component of verb semantics. Together, these approaches indicate that spatial schematization plays a central role in verb comprehension, but differ in their methodological aims: experimental studies provide evidence for online simulation, whereas normative approaches characterize shared semantic patterns across items. Within this context, existing spatial norming datasets remain limited in scope. To our knowledge, no normative datasets in Spanish systematically characterize verbs in terms of spatial image-schematic features. The present study addresses this gap by extending spatial norming methodologies to Rioplatense Spanish and examining the role of syntactic congruence in trajectory-based representations.

Syntactic congruence and spatial representations of events

Within cognitive and psycholinguistic research, syntactic structure has long been recognized as a central factor in the organization of event representations. Canonical alignments between syntactic and semantic roles—typically expressed through subject–verb–object ordering—contribute to the iconic mapping between linguistic form and conceptual structure, whereby grammatical organization reflects salient aspects of event structure (Givón, 1990; Jackendoff, 1990; Langacker, 2008).

From this perspective, syntactic organization provides a structural template that guides the interpretation of actions and relations in language. Experimental research on sentence comprehension has shown that the assignment of thematic roles and the linear ordering of constituents influence the construction of situation models and event simulations, even when spatial information is not explicitly encoded (Zwaan & Radvansky, 1998; Zwaan, 2004; Chatterjee, 2001). These findings suggest that syntactic structure can modulate how events are mentally represented and simulated.

Despite this evidence, existing spatial norming studies have not explicitly examined the role of syntactic congruence—understood here as the alignment between canonical syntactic structure and the spatial trajectory implied by an event—in shaping speakers' judgments about verb meaning. In the present study, syntactic congruence refers specifically to the alignment between canonical subject–verb–object structure and the directionality of the spatial trajectory associated with an event. As discussed below, spatial configurations are often implicitly organized according to agent–patient relations, and deviations from this alignment may reduce the plausibility of a given spatial interpretation. However, this dimension has remained largely unexplored within normative approaches to spatial image schemas.

This study addresses this gap by manipulating syntactic congruence alongside spatial trajectory within a normative framework. By contrasting congruent and incongruent configurations across multiple spatial axes, it examines whether alignment between syntactic structure and trajectory-based image schemas facilitates the acceptance of spatial representations. It thus provides a normative resource that extends previous work on spatial image schemas and offers a new empirical perspective on the interaction between syntax and spatial grounding in verb semantics.

Research questions

Building on previous experimental and normative research on spatial image schemas and verb semantics, the present study aims to provide a systematic normative characterization of how spatial structure and syntactic organization contribute to verb meaning. To this end, the study is guided by three research questions, each addressing a distinct but complementary aspect of spatial representation

in verb semantics. First, we ask whether speakers exhibit systematic preferences for specific spatial trajectories when associating verbs with image-schematic representations. Second, we examine whether these trajectory preferences vary across different spatial axes (horizontal, vertical, and sagittal), revealing differential patterns of spatial organization. Third, we investigate whether syntactic congruence between canonical sentence structure and spatial trajectory influences speakers' acceptance of image-schematic representations. Each research question is addressed through a dedicated analysis, providing a structured framework for presenting results.

Methods

Ethics statement, openness, and reproducibility

The research adhered to the standard ethical procedures outlined by the Research Ethics Committee for Human Subjects, Universidad de la República (Udelar). All experimental materials, scripts, data, and application code generated during this study are available at: https://osf.io/qrshe/overview?view_only=c836f3e3295c49e5b64d7357de4b4b4d

Participants

A total of 639 native speakers of Rioplatense Spanish participated voluntarily (410 from Uruguay and 229 from Argentina). Participants ranged in age from 18 to 65 years ($M = 36.58$, $SD = 13.83$). The sample included 494 women, 133 men, and 12 participants identifying as another gender; 577 were right-handed and 62 left-handed. Most participants reported tertiary education ($n = 548$), while 91 reported secondary education, either completed or incomplete.

Recruitment was conducted via social media platforms (Instagram, Facebook, WhatsApp, Twitter). Participants were informed about the study goals and provided digital informed consent before beginning the task. Inclusion criteria required participants to be 18 years or older, native speakers of Rioplatense Spanish, and residents of Uruguay or Argentina. Individuals over 65 and non-native speakers were excluded to ensure linguistic homogeneity and minimize potential effects of cognitive aging on lexical processing (Salthouse, 1996; Burke & Shafto, 2004; Craik & Salthouse, 2011).

Materials

Verb selection. Seventy-five Spanish verbs were selected based on the English spatial norms reported by Meteyard and Vigliocco (2009), as well as prior exploratory and normative work on spatial representations in Spanish verb semantics. The corpus included both concrete action verbs (e.g., *empujar* “to push,” *subir* “to climb”) and abstract verbs (e.g., *pensar* “to think,” *recordar* “to remember”). Translations were verified using the OPUS parallel corpus (Tiedemann & Nygaard, 2004), selecting the Spanish equivalent with a frequency above 60% to ensure semantic equivalence and cross-linguistic comparability. All verbs

were classified as transitive according to the Diccionario de la Real Academia Española (RAE), ensuring compatibility with the canonical subject–verb–object syntactic frame used in the experimental stimuli.

Stimuli. Each stimulus consisted of a hieroglyphic sentence (Meteyard & Vigliocco, 2009) in which a circle represented the subject (agent) and a square represented the object (patient), followed by the written verb (e.g., *circulo empuja cuadrado* “circle pushes square”). Syntactic congruence was manipulated by varying the alignment between the direction of the spatial trajectory and the canonical subject–verb–object structure, while the sentence itself remained constant. In congruent trials, the trajectory followed the agent-to-patient direction, whereas in incongruent trials this alignment was reversed. Participants viewed schematic diagrams representing spatial features along three axes (horizontal [left–right], vertical [up–down], and sagittal [front–back, defined relative to the viewer’s perspective]) and six directions (e.g., left–right, up–down, back–front). Each verb appeared across 12 trials, combining all possible spatial configurations in both syntactic conditions (congruent/incongruent). Participants responded “yes” or “no” to indicate whether a given spatial configuration matched the meaning of the verb. All materials and scripts were created using the open-source platform lab.js (Henninger, 2022).

Design

The study employed a normative design incorporating a manipulation of syntactic congruence, in which all participants were exposed to all experimental conditions. The dependent variable was the acceptance of spatial features —operationalized as the proportion of “yes” responses indicating that a schematic spatial configuration matched the meaning of a given verb. Two independent categorical variables were considered: Verb (75 items) and Syntactic congruence (two levels: congruent vs. incongruent). A within-subjects structure was implemented within the task, allowing each participant to evaluate multiple configurations for each verb and thereby reducing interindividual variability. Analyses were conducted at the item level, focusing on both verb-specific patterns and aggregate effects of syntactic congruence. Each verb was evaluated across 12 trials, combining all spatial axes, directions, and syntactic conditions.

Results

Reliability of spatial judgments

Before examining spatial preferences and syntactic effects, we assessed the reliability of participants’ spatial judgments to determine whether responses reflected shared patterns rather than random variation. Inter-rater agreement across participants was evaluated using Fleiss’ Kappa, a statistic suitable for assessing agreement among multiple raters in categorical judgment tasks.

The overall level of agreement was fair ($\kappa \approx .28$), indicating moderate consistency in participants' judgments regarding the spatial features associated with each verb. At the item level, 56% of the verbs showed fair agreement, 30% slight agreement, and 11% poor agreement. Only three verbs (*baja*, *escurre*, and *regresa*) exhibited non-significant agreement across participants.

Despite variability across individual items, these results indicate that participants showed partial convergence in their spatial feature selections, with stronger agreement for some verbs than for others. Although previous spatial norming studies did not report formal inter-rater reliability indices, the level of agreement observed here indicates that responses are not random, but show structured patterns of agreement across participants.

Spatial trajectory and axis-specific preferences

To address the first and second research questions, we examined whether speakers exhibit systematic preferences for specific spatial trajectories when associating verbs with image-schematic representations, and whether such preferences vary across spatial axes. Following the logic of normative studies on verb semantics, these analyses focused on syntactically congruent stimuli, where the canonical mapping between syntactic structure and event representation is preserved.

Table 1: Acceptance rates by spatial axis and direction.¹

Axis	Direction	Mean "Yes"	SD
Horizontal	Left	.39	.08
Horizontal	Right	.42	.09
Vertical	Up	.37	.09
Vertical	Down	.40	.07
Sagittal	Back	.41	.08
Sagittal	Front	.41	.08

At the item level, chi-square goodness-of-fit tests were conducted to assess whether acceptance rates for spatial configurations deviated from a uniform distribution within each verb. Out of the 75 verbs included in the dataset, 20 items showed significant deviations ($p < .05$), indicating that only a subset of verbs elicited reliable preferences for particular spatial trajectories. These results demonstrate that spatial trajectory preferences are not randomly distributed, but emerge systematically at the level of individual lexical items when syntactic structure is congruent.

To characterize spatial patterns at a more general level, acceptance rates were also examined separately for each spatial axis and direction, aggregated across verbs. As summarized in Table 1, mean proportions of "Yes" responses were comparable across horizontal, vertical, and

sagittal axes, with similar levels of variability. No strong global preference for a particular axis or direction emerged at this aggregated level, suggesting that coarse geometric dimensions alone do not account for spatial acceptance patterns.

Crucially, the contrast between item-level and aggregate analyses indicates that spatial schematization in verb semantics operates at a fine-grained, lexically constrained level. Rather than reflecting broad axis-based biases, spatial preferences emerge within axes for specific verbs, consistent with the view that image-schematic representations are shaped by verb-specific semantic properties. For verbs showing significant goodness-of-fit effects, the spatial configuration with the highest proportion of "Yes" responses was identified as the dominant trajectory for that item. A detailed overview of these verbs, including their preferred spatial axis and direction, along with the corresponding χ^2 statistics, is provided in Table 2.

Table 2: Item-level spatial trajectory preferences under syntactic congruence.²

Verb	Selected spatial features	Proportion "Yes"	χ^2	p-value
admira	Vertical up	.87	59,25	< .001
alza	Vertical up	.86	52,89	< .001
aparta	Horizontal right	.91	76,94	< .001
aplana	Vertical down	.86	51,96	< .001
baja	Vertical down	.82	9,78	.000
barre	Horizontal right	.90	32,96	< .001
castiga	Vertical down	.83	24	< .001
caza	Sagittal	.87	13,5	< .001
comienza	Horizontal right	.79	18,13	< .001
corre	Horizontal right	.96	44,3	< .001
cuelga	Vertical down	.74	25,25	< .001
declina	Vertical down	.76	15,29	< .001
escurre	Vertical down	.76	5,76	.010
gatea	Horizontal right	.81	22,34	< .001
patea	Horizontal right	.94	40,69	< .001
piensa	Vertical up	.90	34,88	< .001
rebota	Vertical down	.75	14	< .001
regresa	Horizontal left	.77	6,54	.010
sube	Vertical up	.75	6	.010
suda	Vertical down	.73	20,31	< .001
vierte	Vertical down	.87	52,12	< .001

Taken together, these findings demonstrate that spatial path preferences in verbal semantics are systematic, at least for a subset of verbs, but remain lexically specific rather than

¹ Values represent mean proportions of "Yes" responses computed across the full set of 75 verbs; SD = standard deviation.

² For each verb, the dominant spatial configuration and the corresponding χ^2 goodness-of-fit statistic and p-value are reported. Only verbs with significant deviations from a uniform distribution are included.

globally distributed: they reliably emerge under syntactically congruent conditions for some verbs, while remaining weak or absent at the level of global axis-based aggregation. This pattern addresses the first two research questions and motivates the examination of syntactic congruence as a structural factor shaping spatial interpretations, a topic explored in the next section.

Effect of syntactic congruence

To address the third research question, we examined whether syntactic congruence between canonical sentence structure and spatial trajectory influenced participants' acceptance of spatial features. Unlike the previous analyses, which focused on syntactically congruent configurations, this analysis directly contrasted congruent and incongruent stimuli. A chi-square analysis revealed that syntactic congruence significantly influenced response patterns.

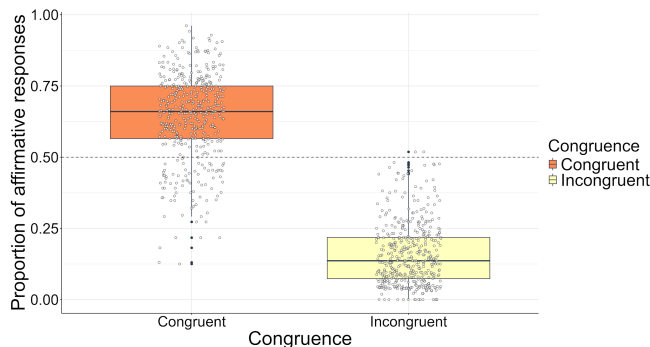


Figure 1: Effect of syntactic congruence on spatial feature acceptance

Participants showed higher acceptance rates (“Yes” responses) for congruent stimuli—where spatial direction aligned with the canonical subject–verb–object structure—than for incongruent configurations. As illustrated in Figure 1, the mean proportion of “Yes” responses exceeded the 0.5 chance level for congruent conditions, whereas incongruent items elicited predominantly “No” responses. This pattern indicates that alignment between syntactic order and spatial trajectory is associated with greater acceptance of spatial configurations, suggesting that syntactic structure constrains the acceptance of spatial configurations in this task.

Summary of results

Taken together, the results reveal structured spatial organization in verb semantics across multiple levels of analysis. Spatial trajectory preferences emerged reliably for a subset of individual verbs under syntactically congruent conditions, indicating that some verbs elicit stable and non-random spatial mappings. At the same time, aggregated analyses showed no strong global biases across spatial axes,

suggesting that spatial schematization is not driven solely by coarse geometric dimensions.

In addition, syntactic congruence significantly modulated acceptance of spatial configurations, with canonical alignment between syntactic structure and spatial trajectory associated with higher acceptance rates. These findings highlight the interaction between lexical semantics, spatial structure, and syntactic organization in shaping participants' spatial judgments. Together, the results provide a normative baseline for spatial schematization in Rioplatense Spanish and offer a set of verb items suitable for future experimental and cross-linguistic research.

General Discussion

The present study examined how spatial image schemas are associated with verb semantics in Rioplatense Spanish, combining a normative approach with a manipulation of syntactic congruence. The results indicate that spatial preferences in verb-related judgments are not randomly distributed, but instead reflect structured patterns that emerge at the level of individual lexical items and are sensitive to syntactic organization.

At the level of individual verbs, a subset of items showed reliable preferences for specific spatial trajectories under syntactically congruent conditions. This pattern suggests that, for some verbs, participants converge on similar spatial interpretations when mapping linguistic input onto schematic representations. Importantly, these preferences did not generalize uniformly across spatial axes when responses were aggregated, indicating that spatial structure is not driven by global directional biases but rather emerges at a finer-grained, verb-specific level.

These findings are consistent with accounts in cognitive linguistics and embodied cognition that propose that conceptual knowledge may be grounded in recurrent sensorimotor experience and organized through schematic structures (Lakoff & Johnson, 1980; Barsalou, 1999). They are also compatible with approaches that treat verbs as lexicalizations of events or happenings, for which spatial and relational dimensions may provide structuring constraints on interpretation (De Almeida, 2015). At the same time, the present results do not by themselves establish that such spatial schematization constitutes the semantic representation of verbs. Instead, they provide normative evidence that speakers systematically associate certain verbs with particular spatial configurations in a structured judgment task.

Syntactic congruence as a constraint on spatial schematization

Beyond verb-specific spatial preferences, the results show that syntactic congruence significantly modulates participants' acceptance of spatial configurations. Participants were more likely to endorse spatial representations when the direction of the trajectory aligned with canonical subject–verb–object structure, suggesting that syntactic organization constrains how spatial

interpretations are constructed in this task. This effect can be interpreted within frameworks that emphasize the role of syntax in structuring event representations and guiding the mapping between grammatical form and conceptual structure (Givón, 1990; Langacker, 2008). Canonical alignments between grammatical and thematic roles may facilitate coherent mappings between linguistic input and schematic representations, thereby increasing the acceptability of certain spatial configurations. These findings may also reflect general preferences for aligning agents and patients with directional schemas, rather than a direct influence of syntactic structure on underlying semantic representations. Accordingly, the results suggest that syntactic structure constrains the acceptance of spatial interpretations in this normative task, without necessarily determining their semantic content.

Methodological and interpretative considerations

Several aspects of the results call for a cautious interpretation. First, inter-rater agreement was modest, and only a subset of verbs showed strong convergence in spatial judgments. This suggests that spatial associations are not uniformly shared across all verbs, but vary across lexical items, with some verbs eliciting more stable and consistent spatial mappings than others. Importantly, this variability may also reflect the fact that trajectory-based schemas do not equally capture the semantics of all verbs, which may instead be better represented by other image schemas, such as containment or support.

Second, the task required participants to explicitly match verbs to schematic spatial configurations, which may encourage the use of imagery, task-specific strategies, or general knowledge about event structure. While this may partly reflect task demands, it is also consistent with accounts of embodied cognition, according to which semantic representations involve perceptual simulation. In this sense, the observed spatial preferences may capture aspects of how verb meaning is constructed through mental imagery, rather than reflecting task-specific artifacts alone.

At the same time, the presence of systematic agreement for a subset of verbs suggests that these responses are not arbitrary, but reflect structured and reproducible associations across participants. Finally, the absence of strong axis-level effects in aggregated analyses indicates that spatial preferences are not driven by global directional biases, but depend on verb-specific properties and event structure, reinforcing the importance of item-level analyses in the study of spatial schematization.

Conclusions

This study provided a normative characterization of spatial associations in verb semantics in Rioplatense Spanish, examining how spatial trajectory and syntactic congruence influence participants' judgments.

The results show that a subset of verbs elicits stable and consistent spatial preferences under syntactically congruent

conditions, while others remain more variable. In addition, syntactic congruence systematically modulates the acceptance of spatial configurations, suggesting that alignment between linguistic structure and spatial representation plays a role in how participants construct spatial interpretations in this task.

Importantly, these findings indicate that speakers do not relate verbs to spatial representations in an arbitrary way. Rather, the observed patterns point to structured and reproducible associations that emerge across participants under controlled conditions. While such associations cannot be taken as direct evidence of underlying semantic structure, they are compatible with accounts that emphasize the role of spatial and relational dimensions in the conceptualization of events. In this sense, the present study contributes both a normative resource and an empirical basis for future research. By identifying verbs that show consistent spatial preferences, it enables the selection of controlled stimuli for experimental paradigms designed to examine spatial grounding, embodiment, and the interaction between syntax and conceptual structure in language processing.

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