Semantic-World Knowledge Interactions During Processing

AIM This ongoing study tracks real-time meaning formation using Visual World eye tracking (VWP) to test whether offline (Sentence-Picture Verification; SPV) data challenge the strict compositionality that many formal semantic theories assume. **BACKGROUND** The productivity and systematicity of language suggest linguistic meaning (semantics) is strictly compositional: the meaning of a complex expression is a context-insensitive function of the meanings of its parts (Dowty, 2007; Partee, 1995). But typicality effects caused by **lexical context dependence (LCD)** may pose a challenge: many rules (e.g., adjective+noun) seem sensitive to world knowledge of what the units of composition refer to. For example, *red car, red hair,* and *red squirrel* all elicit different red hues conceptually. LCD effects are found across various expression types in offline tasks (Lee, 2017; Matsuki et al., 2011; Poortman, 2017; Poortman et al., 2018; Ross et al., 2025; Zwaan et al., 2002). Our SPV data (**Fig 1a**) show meaning representation at the end of a sentence is sensitive to world knowledge. The question is when that knowledge is integrated with context-insensitive linguistic knowledge. We are now collecting VWP data to try to answer that question.
HYPOTHESES Proposals suggest LCD effects arise from world knowledge-driven modifications either prior to, during, or after compositional processing: **(H1) Pre-Compositional Modification** preserves compositionality by modifying prototype-based (Rosch et al., 1976) lexical meanings prior to strict composition (Del Pinal, 2016); **(H2) Modification During Composition** challenges compositionality by allowing world knowledge and semantics to mutually modify one another during combination (Pagin & Pelletier, 2007), predicted to lead to LCD effects that arise around 400ms after they are licensed (based on semantic coercion data; e.g., Brennan & Pylkkänen, 2008; Piñango et al., 2006); **(H3) Post-Compositional Modification** preserves compositionality by modification via pragmatic inference post-compositionally, with no access to an expression's part-whole structure (Del Pinal, 2016; Johnson & Keil, 2000); it is temporally delayed, predicted to arise at 1800ms after LCD effects are licensed (based on SPV results; see below).
EXP1 SPV evidence (Horchak & Garrido, 2021; Prystauka et al., 2023; Sato et al., 2013) suggests semantics interacts with object-state typicality. In our replication, subjects (n=288) read English sentences like *Oliver* VERB*ed the beach ball* then indicated whether an object (pictured 1000ms later) was mentioned. Normed images depicted objects (beach ball) either in a typical (inflated) or atypical (deflated) state **(Fig. 1a).** We used no-change (*notice*) or state-change verbs that either describe change toward an object's typical (*inflate*) or atypical (*deflate*) state over time. Crucially, while inflating and deflating a beach ball describe the same set of object states, their order differs: *inflate* describes change to a beach ball's typical state, whereas *deflate* describes change to an atypical state. A semantics-world knowledge interaction between object-specific typicality and semantic event structure predicts an interaction between sentence and picture—an LCD effect. *Notice* exemplifies the baseline typical condition; the crucial comparison is between *inflate/deflate*. Generalized linear mixed effects models (outcome: response times; RTs) confirm an interaction (p<.001; **Fig. 1b):** RTs were faster to typical states in the *inflate* than the *deflate* condition, and RTs were faster to atypical states in the *deflate* than the *inflate* condition. This result is a reference point for our test of real-time meaning computation using VWP in Exp 2 (data collection ongoing).
EXP2 To test the temporal predictions of H1-3 in VWP, subjects (n_{TARGET}=48) hear, e.g., *Oliver* VERB*ed the beach ball* and view displays like **Fig. 2a**. Verbs (*notice, inflate, deflate*) match both objects (*beach ball, balloon*) to limit predictive processing. Planned Growth Curve Analyses contrasting *inflate/deflate* conditions will test *when* during processing fixations match SPV results, indicative of a LCD effect (**Fig. 2b**): **(H1)** at the noun phrase, due to pre-compositional lexical modification; **(H2)** just after rapid semantic composition; **(H3)** well after compositional processing.
DISCUSSION Theories of linguistic meaning have long debated whether meanings combine compositionally and how this process may be influenced by context and world knowledge. While SPV data provide rich information after meaning formation, VWP supports precise online tracking, making it possible to address whether LCD effects challenge strict compositionality.

Figure 1. *Sentence-Picture Verification.*

(a) Stimuli (normed for typicality)

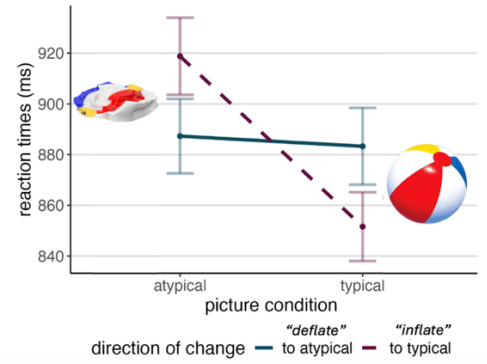
Images

atypical *typical*

Sentences

(a) Oliver noticed the beach ball. NO CHANGE
(b) Oliver inflated the beach ball. TO TYPICAL
(c) Oliver deflated the beach ball. TO ATYPICAL

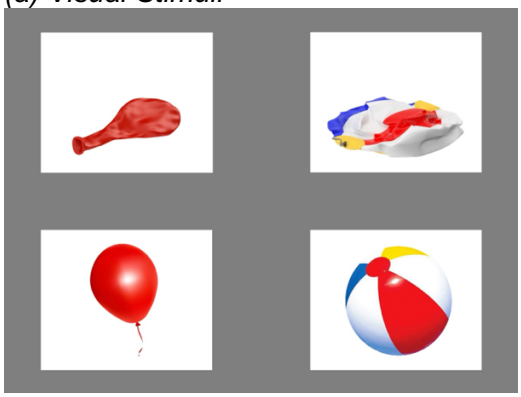
(b) Observed Mean Reaction Times and SEs



Note. Post-sentence RTs indicate an interaction of semantic state-change event structure and object state typicality, indicating a trade-off relation between favoring the typical over atypical object state (world knowledge) and favoring an event's resultant over initial state (linguistic knowledge), leading to faster RTs to the atypical state (the event's resultant state) in the to-atypical condition.

Figure 2. *Eye Tracking in the Visual World Paradigm.*

(a) Visual Stimuli



(b) Predictions for Each Hypothesis

At what point in the sentence will fixations match SPV results, indicating an LCD effect?

	Oliver	**VERB** *e.g., inflated*	**NOUN PHRASE** *e.g., the beach ball*	AT 400MS AFTER NOUN OFFSET	AT 1800MS AFTER NOUN OFFSET
H1			SPV		
H2				SPV	
H3					SPV

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