Temporary ambiguity and memory for the context of spoken language use

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Spoken language is interpreted incrementally, with listeners considering multiple potential referents as words unfold over time[1-2]. When interpreting an expression like *the yellow banana* in a scene with potential referents, upon hearing *the yellow*, listeners look at objects matching the initial words (yellow banana, yellow candy), and following *banana,* fixate objects matching subsequent words (brown banana), before identifying the referent[3]. The impact of incremental processing on enduring memory for linguistic experience, however, is poorly understood.

Measures of recognition memory following conversation reveal that speakers and listeners correctly recognize both past referents and contrasting items in the context (e.g. yellow & brown banana when referencing a yellow banana)[4]. Further, listeners form memorial representations of words that were predicted but not actually read[5]. The locus of the memorial boost for items that partially match the unfolding expression is unknown. Modifying words and phrases like *yellow* and *strawberry flavored* activate corresponding referential representations. Yet, the form of the referential phrase may circumscribe an initial set of candidate referents, ruling out items that only match subsequent words (e.g. chocolate flavored cake when hearing *strawberry flavored cake*). Two experiments test the hypothesis that it is the temporary activation of potential referents that modulates memory for the context of language use, with both early and late competitors encoded in memory better than items that never matched the unfolding phrase. We predict the longer the period of temporary activation, the more likely an item in the context will be remembered. Alternatively, if memory for items in the context is driven by temporary referential activation, items temporarily consistent with the initial part of a phrase will be better remembered than those that are ruled out by the initial words, and only match later words.

In **Exp1** (E1, N=147, mTurk), Ps viewed a series of 6-image grids and heard instructions to click on an image in the grid **(Fig1)**. Referring expressions were pre-nominally or post-nominally modified (*Click on the strawberry cake* vs. *Click on the cake that's strawberry flavored*). Grids had a target, a competitor matching the *initial* part of the phrase (early-c), one matching the *latter* part (late-c), two images that did not match but matched one competitor (no-c), and two unrelated fillers. In the pre-nominal condition (*strawberry cake*) the early-c matched early (e.g. strawberry muffin); in the post-nominal condition (*cake that's strawberry flavored*), the early-c matched the noun (e.g. cake that's chocolate flavored), and vice-versa for the late-c. A 2AFC memory test followed: Ps saw an old image (seen in reference task), and a similar, new image, and were asked to click the old image. **Results:** Mixed-effects analysis of 2AFC data **(Fig2)** revealed recall was significantly higher for targets than non-targets (z = -27.02), for competitors (early-c & late-c) vs. non-c (z = 9.70); and early-c more than late-c (z = 3.91). These competitor effects (C vs no-c, and early-c vs. late-c) interacted with utterance form: both were larger with post-nominally modified phrases (z's > - 2.4). One explanation is that the period of temporary activation of competitors was longer for post- vs. pre-nominal modifiers (~1000 vs 800ms).

E2 (N=128, mTurk) added a speech rate manipulation. If the memory boost for competitors in E1 was due to the length of temporary activation, competitors should be better remembered in the slow vs. fast condition. **Results:** Memory **(Fig3)** for targets > non-targets (z = -20.01), for competitors > non-competitors (z = 4.28), and for early-c > late-c (z = 5.85). Overall, memory was better for slow than fast speech (z = 2.21). Critically, speed interacted with the competition effect (z = 3.17), such that enhanced memory for early vs. late competitors was magnified when speech was slow (this effect was similar for pre/post mod).

Conclusion: Temporary activation of potential referents shapes memory for the context in which language is used. Items that temporarily matched the unfolding expression were better remembered than those that did not, indicating that temporary activation can support context memory. The longer the period of temporary activation, the stronger the boost, particularly for items that were temporary referential candidates. This indicates that both temporary activation, and temporary consideration as a referent improve memory for the context of language use.

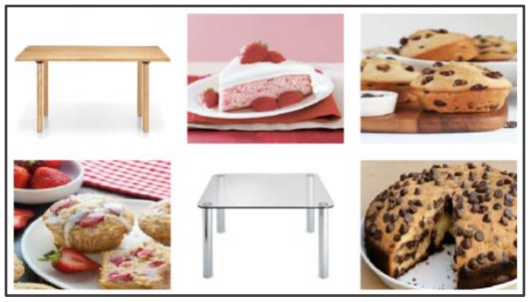
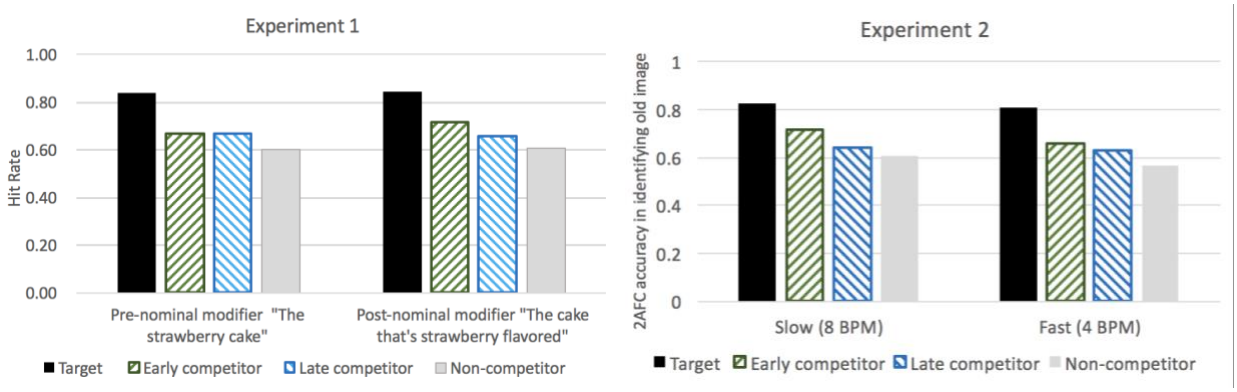


Figure 1: Example stimulus grid for test sentence *"Click on the strawberry cake"* (pre-nominal condition), and *"Click on the cake that's strawberry flavored"* (post-nominal condition).



Figures 2-3: Hit rate (E1) and accuracy (E2) on memory test by condition. For E2, data in figure are collapsed across pre/post-nominal modification. Given the example in Figure 1, for pre-nominal modifiers (*Click on the strawberry cake*), the Target corresponds to memory for the strawberry cake, the Early competitor is the strawberry muffins, the Late competitor is the chocolate cake and the Non-competitor corresponds to the chocolate muffins. For post-nominal modifiers (*Click on the cake that's strawberry flavored*), the Target corresponds to memory for the strawberry cake, the Early competitor is the chocolate cake (i.e. cake that's chocolate), the Late competitor is the strawberry muffins (i.e. muffins that are strawberry flavored) and the Non-competitor corresponds to the chocolate muffins.

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