The role of communicative strategies and cognitive control on referential efficiency across the adult lifespan

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Efficiency is often characterized as the avoidance of redundancy (i.e. make your contribution as informative as required *but not more*) [1,2]. Recent work, however, calls into question this view, showing that an efficient speaker uses referential choices to facilitate a listener's identification of referents [3]. A prediction follows from this account: some contexts will lend themselves to redundancy, and an efficient speaker will only be redundant when helpful to the listener. Efficiency therefore requires the ability to track contextual information and change strategy when necessary, likely relying on attention switching and working memory (WM). To test this hypothesis, we recruited adults of all ages (given well-known variability in referential choice, cognitive control, and WM [4-6]) to investigate individual differences in referential efficiency.

Experiment 1 - Efficiency and Switching: We assessed referential efficiency by manipulating the visual context (monochrome vs. polychrome conditions, Fig 1). Participants (N=100, ages 19-82) named targets in 4-object displays so that an in-person listener could identify the referent [3]. Previous work demonstrates that color adjectives speed object identification in polychrome displays but delay object identification in monochrome displays [7]. Thus, when presented with both types of displays, a highly efficient speaker should only add color modification on polychrome displays. In this way, being efficient involves responding to changes in the visual environment by actively shifting communicative strategies in a way that benefits the listener. We therefore hypothesized that efficiency would be predicted by attention switching skills (i.e. the ability to rapidly shift between modification strategies during the process of utterance planning, measurable via tasks like the Test of Everyday Attention [8]). We also manipulated communicative pressure: participants were randomly assigned to one of two trial-block orders, either a polychrome block followed by a monochrome block, or vice-versa. For the Poly-Mono order, there's greater pressure to switch communicative strategies as color becomes inefficient in the second block. For the Mono-Poly order, on the other hand, modification in the second block is helpful, but an unmodified noun would also suffice, yielding less pressure to switch to the more efficient color-modification strategy. We thus expect modification to vary with visual context, block order and switching capacity. Our LMER model of color modification (Condition, Order, Switching, Age as FE, maximal RE structure) showed the predicted Condition x Order x Switching interaction (p<.05): for Poly-Mono, better switching appropriately led to less modification in block 2 (Fig 2). Notably, age did not matter: good switchers *of all ages* flexibly adapted to communicative pressures. Other significant results follow from this view of efficiency (Poly-Mono yields more color over-specification and is more sensitive to switching) and from age differences (older adults over-modify in general [4] but less so with better switching skills).

Experiment 2 - Efficiency and Working Memory: We assessed whether referential choices in narrative (where there's less pressure for efficiency but greater necessity to track and recall discourse referents) reflected individual differences in WM (measured via a reading span test [9]). We manipulated communicative pressures for appropriate referential forms by changing the number of characters in the scenes [10]. The same participants from Exp 1 saw two-panel vignettes in random order (Fig 3). For each pair of panels, the participant heard a sentence about the first panel and repeated it, then saw the second panel (with the subject referent from the first panel depicted as the main character) and constructed a story continuation. We assessed referring expressions produced in each condition: 1 character or 2 different sex/gender characters. A variety of factors influence the felicity of different referential forms, but in the 1-character condition, a pronoun is sufficient since there is no ambiguity and one might argue that a repeated name risks inefficiency (pronoun is hence most appropriate), whereas in the 2-character condition, the intended referent competes with another referent, such that a pronoun is more efficient but either a pronoun or name could be appropriate given an efficiency-driven goal of easing the task for the listener. We built an LMER model of pronoun use (Condition, WM, Age as FE and maximal RE structure). We replicated effects of condition [10]: more pronouns for 1-character scenes (p<.001), and age [11]: more pronouns from older adults (p<.01). Importantly, pronoun use varied with WM, mediated by age: more pronoun use for greater WM (p<.01), driven by young adults' behavior (p<.05) (Fig 4).

Our results reveal that age-related differences in referential efficiency depend on both contextual demands and cognitive abilities, highlighting the role of individual differences in reference development across the lifespan. Moreover, those with better cognitive skills were redundant in efficient ways, suggesting that speakers' choices reflect a pressure to facilitate the listener's processing, rather than simply to be brief.

Fig 1. Sample displays

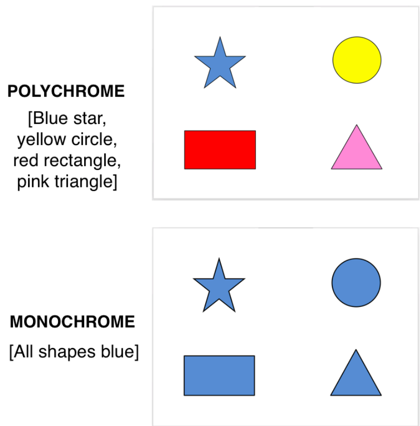


Fig 2. Order x Condition x Switching interaction

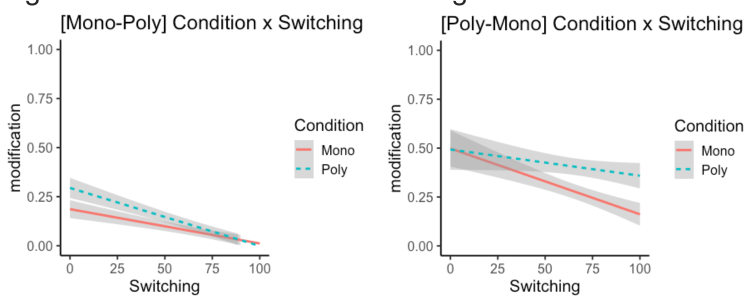
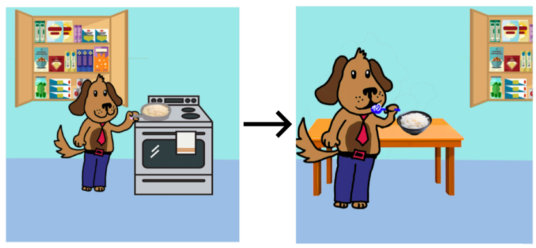
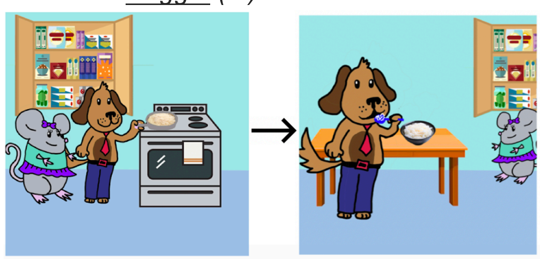


Fig 3. Sample 1- and 2-character vignettes

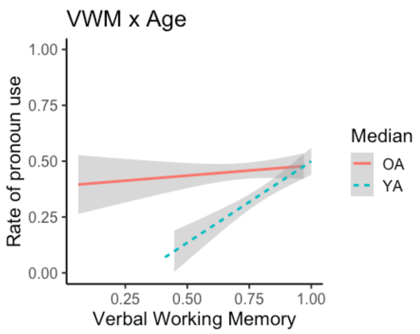


Panel 1: "Doggie (M) cooked rice for dinner."



Panel 1: "Doggie (M) cooked rice with Mousey (F) for dinner."

Fig 4. VWM x Age interaction



(Median split: OA=older adults, YA=younger adults)

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