

The Effects of Name Agreement on Dual-Task Picture Naming

Introduction

Determining the extent to which normal language processing requires attentional resources can significantly affect our understanding of aphasia. Language deficits in individuals with aphasia may arise from the inability to properly allocate attention to certain cognitive processes, including linguistic processes.

The use of resources by different cognitive processes can be studied using dual-tasks. One model of dual-task performance, the central bottleneck (CB) model, suggests that some cognitive processes can be performed simultaneously, while others cannot (Ferreira & Pashler, 2002). According to this model, those processes that cannot occur in parallel require a cognitive resource or resources that are shared by all tasks or domains, which has been referred to as central attention (Johnston, McCann, & Remington, 1995). Three stages of cognitive processing are hypothesized: perception, response selection, and response production (Pashler, 1994). Perception and response production, also referred to as the pre-central and post-central stages respectively, can proceed in parallel under this model. On the other hand, the response selection, or central, stage of cognitive processing cannot.

The psychological refractory period (PRP) paradigm is a particular dual-task paradigm in which presentation of the stimuli for speeded primary and secondary tasks is separated by various stimulus onset asynchronies (SOAs). As SOA is shortened, the reaction time for the second task (RT2) is typically lengthened, and this effect is referred to as the PRP effect (Pashler, 1994). The CB model predicts that an effect localized to the pre-central will be underadditive with SOA, i.e., it will have a smaller effect on RT2 at short SOAs than at long SOAs (see Figure 1). By contrast, an effect localized to the central stage will be additive with SOA and affect RT2 similarly regardless of SOA (see Figure 2).

A semantic picture-word interference (PWI) task has been used to investigate linguistic processing during picture naming (Dell'Acqua, Job, Peressotti, & Pascali, 2007; Ferreira & Pashler, 2002). According to current models of lexical access, lexical retrieval for word production involves at least three stages: lemma selection, phonological word-form selection, and phoneme selection (Dell, Schwartz, Martin, Saffran, & Gagnon, 1997; Levelt, Roelofs, & Meyer, 1999). Semantic interference in PWI tasks has been hypothesized to be a result of increased competition at the level of lemma selection during word production (Schriefers, Meyer, & Levelt, 1990). A (2007) PRP study by Dell'Acqua et al. (2007) found a pre-central locus for the semantic PWI effect.

Name agreement, which is the degree to which participants produce the same name for picture stimulus, has also been hypothesized to manipulate competition at the level of lemma selection (LaGrone & Spieler, 2006). A study by Vitkovitch and Tyrrell (1995) identified three different types of low name agreement. These types included low name agreement due to the use of expansions or abbreviations (LNA-MCN; e.g., telephone for phone, phone for telephone), pictures with multiple correct names (e.g., sofa for couch), and pictures frequently given incorrect names (e.g., ant for spider). Competition during lemma selection was proposed as a possible source of LNA-MCN.

The primary aim of the current study is to examine whether the effects of LNA-MCN can be localized to the pre-central or central stage of the CB model. A secondary aim is to relate the results to previous findings (Dell'Acqua et al., 2007) regarding the PWI effect. The research questions were investigated in a PRP dual-task experiment involving tone identification as the primary task and picture naming as the secondary task. It was hypothesized that if the name agreement effect was underadditive with SOA and thus pre-central, it would be consistent with the conclusions that (1) name agreement and semantic PWI affect the same stage(s) of lexical retrieval and (2) lemma selection would be a likely candidate for the locus of both of these effects. On the other hand, if the name agreement effect was additive with SOA, suggesting a central locus, it would imply that (1) name agreement and semantic PWI affect different stages of word production and (2) the name agreement effect likely has its locus at lemma selection, while semantic PWI affects an earlier stage of lexical retrieval.

Method

Picture stimuli ($n=96$) were taken from the University of California San Diego Center for Research in Language International Picture Naming Project (CRL-IPNP) online database of object pictures and associated normative data (Szekely et al., 2003; Szekely et al., 2004). Half of the picture stimuli had high name agreement (HNA), while the other half had LNA-MCN. The high name agreement pictures were distribution-matched to the low name agreement pictures on the variables of word frequency, word length, image agreement, age of acquisition, and object recognition time based on the dominant picture name.

Participants were 24 university students (age 18-29) with English as their primary language. They had no reported history of speech, language, or hearing impairment. Participants were presented with a tone followed by a picture, which was displayed after a 100- or 1000-ms delay, depending on the SOA condition. They were asked to press a button indicating whether the tone was low, medium, or high in pitch and then to name the picture. Participants were familiarized with the experimental procedure during practice blocks of 18 trials each for each task in isolation and for the dual-task. Next, four blocks of 24 experimental trials were administered. The order of conditions was pseudorandomized. Each condition was presented an approximately equal number of times during each block of trials. Across subjects, each picture was presented in each SOA condition an equal number of times. Tone pitch was randomly assigned on each trial. Participants were instructed to always respond to the tone first by pressing a button on a serial response box and then to the picture by saying the name of the picture. Participants were instructed to respond as quickly and accurately as possible to each task without sacrificing accuracy.

Average RTs across items for each participant in each condition were analyzed with repeated measure ANOVA. Responses that were the dominant or a correct alternative picture name, as determined by Szekely et al. (2004), were included in the analyses as correct responses. Trials containing incorrect responses (9%), voice key errors (2%), incorrect response order (1%), operator error (0.2%), and RT outliers (4%) were excluded from analyses. Separate ANOVAs ($\alpha=0.05$) for picture naming and tone identification reaction times were performed, both with two factors: name agreement (high, low), and SOA (100 ms, 1000 ms).

Results

For tone RTs, only the main effect of SOA was significant ($p < 0.001$). For naming RTs, the main effects of SOA ($p < 0.001$) and name agreement ($p = 0.023$), but not the interaction ($p = 0.975$), were significant. The average effect of name agreement on naming RT was 48 ms in both SOA conditions. This pattern of results shows an additive effect of name agreement and SOA.

Discussion

Results indicate that resolving effects of LNA-MCN requires central attention. The additive effect found in the current study is distinct from the underadditive effect of PWI found by Dell'Acqua and colleagues (2007). This pattern of results is consistent with the hypotheses that (1) name agreement and semantic PWI affect different stages of word production and (2) the name agreement effect likely has its locus at lemma selection, while semantic PWI affects an earlier stage of lexical retrieval.

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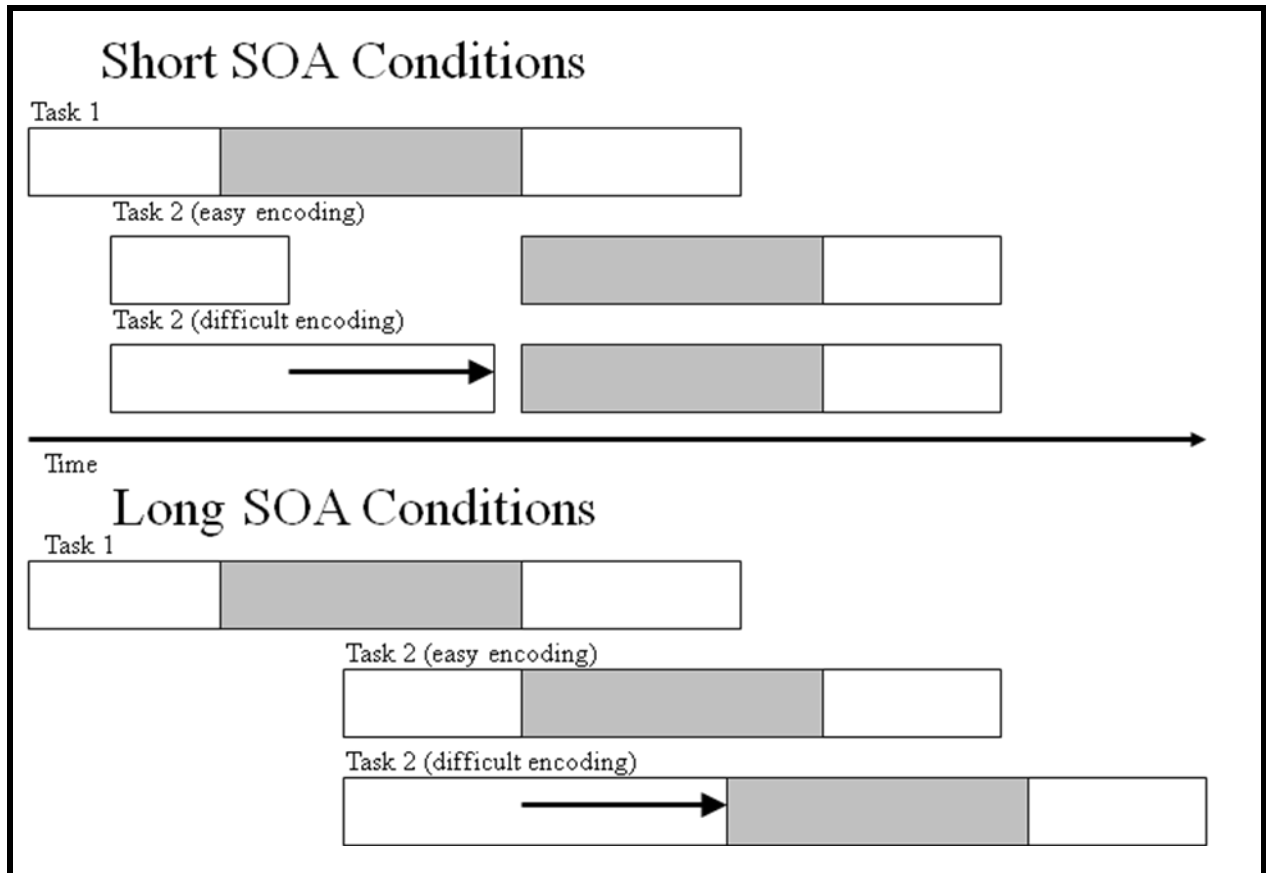


Figure 1. This time diagram of the central bottleneck model demonstrates the prediction that an effect on task 2 reaction time that is localized to the pre-central, perceptual processing stage will be underadditive with stimulus onset asynchrony (SOA), i.e. will have a smaller effect at short SOAs than at long SOAs.

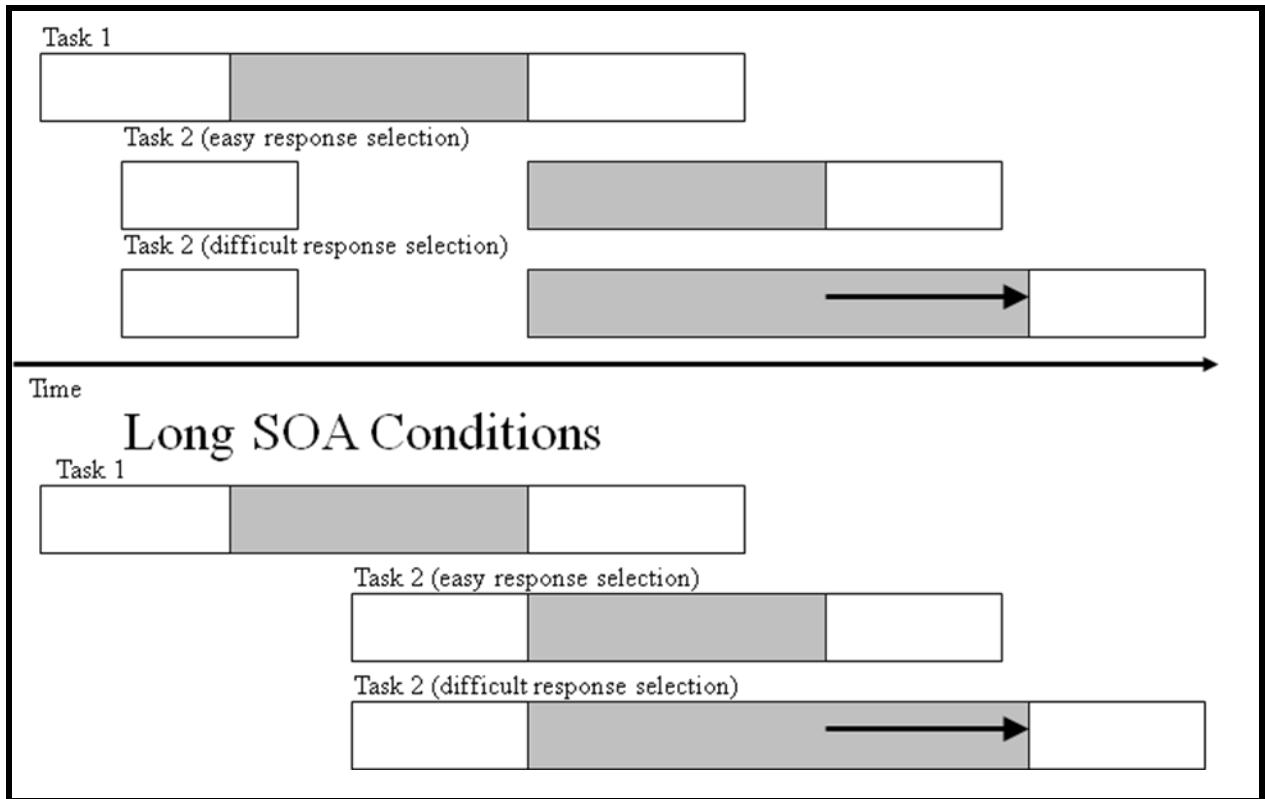


Figure 2. This time diagram of the central bottleneck model demonstrates the prediction that an effect on task 2 reaction time that is localized to the central, response selection stage will be additive with SOA, i.e. will affect RT2 similarly regardless of SOA.

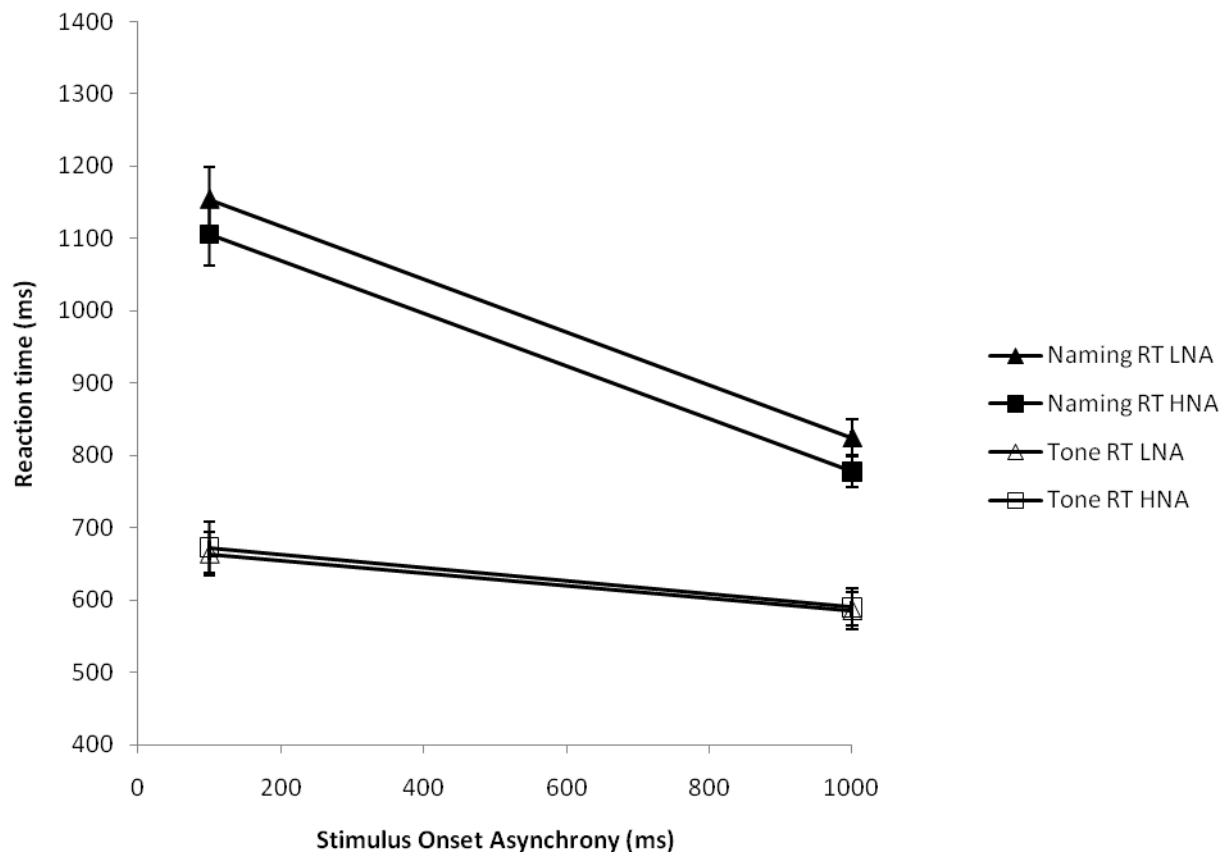


Figure 3. Mean primary-task (tone) and secondary-task (naming) reaction times by condition. Error bars indicate +/- 1 standard error. LNA = low name agreement; HNA = high name agreement.