APHASIOLOGY, 1997, VOL. 11, NO. 4/5, 461–472

Resource allocation in auditory processing of emphatically stressed stimuli in aphasia

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Abstract

Kimelman and McNeil (1987) suggested that improved auditory comprehension for emphatically stressed information might be attributed to recruitment of additional processing resources. This study investigated effects of emphatic stress when it was applied to target words during a semantic judgement task on the auditory processing of non-stressed targets for a lexical decision task. Response time and accuracy were analysed for this dual-task experiment. It was first established that the stimuli contained appropriately placed stressed lexical items and that all subjects benefited from the emphatic stress. Next it was established that all subjects were able to voluntarily trade processing resources in the dual task under investigation, and were able to generate a performance operating curve (POC). Normal subjects showed the predicted performance decrement on the non-stressed word in the context of the preceding stressed word; subjects with aphasia did not. Results are discussed relative to resource allocation theory with normal subjects, and a working memory explanation for aphasic subjects' performance.

Introduction

Auditory comprehension and processing deficits are common to all aphasic syndromes and classifications, and form the core deficit for some definitions of aphasia (Schuell *et al.* 1964). One aspect of auditory processing in persons with aphasia that has been replicated consistently (Bean *et al.* 1989, Kimelman 1991, Kimelman and McNeil 1987, 1989, Pashek and Brookshire 1982), since first being reported by Blumstein and Goodglass (1972), is the phenomenon of improved comprehension and processing in utterances containing emphatic stress. Kimelman and McNeil (1987, 1989) and Kimelman (1991) proposed that contextual or non-local acoustic changes occurring in segments preceding the stressed targets are primarily responsible for enhancing the auditory comprehension abilities of aphasic persons under these conditions by providing extralinguistic cues that signal increased importance of subsequent information. They proposed that the increased saliency of emphatically stressed stimuli might be explained within a resource allocation framework. Consistent with limited capacity theories of resource allocation (Kahneman and Treisman 1984, Navon and Gopher 1979), these authors suggested that improved auditory comprehension for emphatically stressed information might be attributed to the recruitment of additional processing resources.

Limited capacity resource allocation theory posits that, if two difficult processing

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0268–7038/97 $12·00

tasks share the same pools of resources, temporary modifications of the allocation policy towards one of the tasks will result in decreased performance for one task and increased performance for the other. This disruption of performance is inevitable, provided the two tasks are sufficiently difficult and the available resources are insufficient to meet the processing needs of both tasks. Adhering to a limited capacity resource allocation theory, one would predict that if improved auditory comprehension for emphatically stressed segments is due to an increased allocation of resources, then a corresponding decrease in performance must occur for immediately following non-stressed segments sharing those same resources. Changes in performance would be indicated by reciprocal changes in response time and accuracy between the emphatically and normally stressed segments.

Given the demonstrated influence of emphatic stress on auditory processing, further study is needed to explicate the information-processing mechanisms responsible for such changes. To date no studies have systematically investigated resource allocation in auditory processing of emphatically stressed stimuli. The primary purpose of this study was to examine the effects of emphatic stress applied to target words on auditory processing of subsequent unstressed target words, and the degree to which those effects can be attributed to processing resources.

Method

Subjects

Twelve adult males with aphasia and 12 non-brain-injured adult control subjects were selected to participate in this study. Mean age was 65·6 years (SD = 4·9) for the aphasic subjects and 63·0 years (SD = 7·6) for the control subjects. All were premorbidly right-handed and native English speakers, as determined by self-report. Adequate hearing for the task was determined through pure-tone threshold and word-discrimination testing. Motor integrity for all subjects was judged acceptable if the subjects demonstrated the ability to press a designated computer mouse button within 2000 ms for at least 30 out of 40 responses during several experimental practice trials. All subjects achieved an immediate story retelling score at or above 9·33 and a delayed/immediate recall ratio exceeding 15·74% (i.e. two standard deviations above the mean for mildly demented individuals) on the Story-Retelling Test (SRT) (Bayles *et al.* 1989), a subtest of the Arizona Battery for Communication Disorders of Dementia (Bayles and Tomoeda 1991). All aphasic subjects had a single focal lesion confined to the left cerebral hemisphere, as confirmed by CT or MRI scans and clinical neurological examination by a neurologist. Months post-onset ranged from 34 to 219 ($M = 80·5$, SD = 49·5). Scores below 13·86 on the Shortened Porch Index of Communicative Ability (SPICA) (DiSimoni *et al.* 1980, Duffy and Keith 1980) and 14·14 on the Revised Token Test (5-RTT) (Arvedson *et al.* 1985, McNeil and Prescott 1978) were used to select performance within the aphasic range and scores above these levels for the normal range. The aphasic group mean SPICA score was 12·03 (SD = 1·14) and the mean 5-RTT was 12·74 (SD = 1·14). Generally, their communicative abilities were mild to moderately impaired. The control group mean SPICA score was 14·66 (SD = 0·33) and the mean 5-RTT was 14·77 (SD = 0·20).

Stimuli

Stimuli were 160 digitally recorded and edited sentences containing two target words (T1 and T2) embedded in the connecting phrase 'We saw the T1 and the T2 today'. Target words for the semantic judgement task (T1) were 10 frequently occurring nouns selected as first-order exemplars from two common categories (i.e. animals and clothing) in general American English conversation. Commonality of the categories and target words was determined using frequency of occurrence data (Battig and Montague 1969, Francis and Kucera 1982). The 10 semantic distractors were out-of-class words similar in overall acoustic duration and frequency of occurrence. All semantic targets and semantic distractors were single-syllable, highly concrete words with a frequency of occurrence exceeding 10 per million. The same semantic targets and distractors were presented in both the stressed and non-stressed conditions to reduce the possibility of performance differences resulting from word-specific differences. Target words for the lexical decision task (T2) were 10 single-syllable, highly concrete nouns with a frequency of occurrence exceeding 10 per million. The 10 lexical distractors for this task were single-syllable non-words that were phonotactically permissible and similar in overall duration to the lexical targets. No words used in the semantic judgement task (T1) as either correct or out-of-class distractors were used as real-word targets for the lexical decision task (T2). The semantic targets, semantic distractors, lexical targets, and lexical distractors used in this experiment are listed in the Appendix.

For the experimental task (C), emphatic stress was applied to the T1 words in half of the sentences; T2 words were always produced with normal stress. The purpose was to determine the differential effects on T2 performance when emphatic stress was or was not applied to T1.

Recording

Sentences were digitally recorded by a male speaker using Standard American English at a normal conversational speaking rate of 190–210 syllables per minute (Yorkston and Beukelman 1980) maintaining a normal stress pattern throughout the entire utterance. The same sentences were then digitally re-recorded at the same rate, but this time with emphatic stress applied to all T1 words (i.e. all semantic targets and semantic distractors). The digital recordings were collected with a fixed Realistic back electret condenser microphone in a sound-treated room using CSpeech (Milenkovic 1988), running on a Dell Dimension XPS-466V 486/DX2 66 MHz computer equipped with an IBM M-ACPA (Multimedia Audio Capture and Playback Adapter) A/D/A card. These speech signals were low-pass filtered at 10·5 kHz and digitized at 22 kHz directly onto the computer hard disk. The 160 stimulus sentences were digitally constructed from the sentences produced by the speaker. The target words used in the semantic judgement and lexical decision tasks, and the semantic and lexical distractors, were digitally edited from the originally recorded sentences, then stored as independent computer files. The three connecting phrases (i.e. 'we saw the', 'and the', 'today'), designated P1, P2, and P3, respectively, were also digitally stored. All digital editing was accomplished through CSpeech and occurred at zero-axis crossing points on the waveform closest to the onset and termination of spectral acoustic energy for each segment. Stimuli were then reconstructed by sequentially combining the appropriate files to generate the necessary sentences. A listening task was conducted with 10 additional subjects to validate the stressed and non-stressed recorded sentences. Only those targets and distractors achieving 95% agreement for two repetitions across all 10 judges (i.e. 19 of 20) were considered for inclusion as valid experimental stimuli.

The experimental sentences were reconstructed using one exemplar of each of the three connecting phrases. These three standard phrases were originally recorded in sentences produced without emphatic stress on either target. These non-stressed phrases were designated P1n, P2n, and P3n. One additional connecting phrase (P1s) was selected and edited to represent the initial connecting phrase (i.e. 'we saw the') produced when the semantic judgement task was emphatically stressed. The purpose was to retain and subsequently reproduce the acoustic cues preceding the emphatically stressed target that may contribute to improved auditory processing. Each sentence began with either P1n or P1s (i.e. the non-stressed and stressed versions of P1). Next, the appropriate T1 was added, followed by P2. To avoid unintentionally stressing the always non-stressed word (T2) and the P2 phrase in the stressed condition sentences, the stressed sentences were digitally reconstructed by removing both the P2 phrase and the T2 word from the stressed sentence, and replacing them with the same digitally edited phrase and word from the identical sentence produced without emphatic stress. This minimized the possibility of the acoustic cues for the stressed target (T1s) continuing into the unstressed word (T2). The same production of 'today' (P3) was used to construct all sentences. The resulting 160 reconstructed sentences were then arranged and randomized as previously indicated.

Procedure

Each subject participated in two sessions, each lasting approximately 2 hours. The two sessions occurred on separate days, with no more than 3 days between sessions. All preliminary and experimental testing was conducted by a single experimenter in a quiet laboratory. Subjects listened to each computer-digitized and presented sentence through a Labtec CS-550 loudspeaker at a listening level determined as comfortable by each subject. Listening levels ranged from 65 to 80 dB SPL. Prior to each task, explicit instructions emphasizing the importance of responding both accurately and quickly were provided, along with several practice trials. Subjects made immediate yes/no semantic judgements and lexical decisions by pressing either the left or right button on a modified stationary computer mouse to indicate if the first target word was a constituent of the given semantic category or if the second target represented a real word. The computer algorithm CPlayT (Milenkovic 1989) was used for presenting the stimuli and obtaining the necessary accuracy (AR) and response time (RT) data.

Prior to the administration of the primary experimental condition (task C), it was necessary to demonstrate that the subjects selected for study actually benefited from emphatic stress. Secondly, to legitimately suggest that resources were being manipulated, or that emphatic stress demanded more resources, it was necessary to demonstrate that such resources could be differentially allocated between the two dependent measures. Therefore, two preliminary tasks were conducted to determine which subjects would be eligible to participate in the experiment. The first task (A), using a single response, determined which potential subjects showed a reduced mean response time as a result of emphatic stress during a semantic judgement task. The second preliminary task (B) evaluated the potential subject's ability to allocate cognitive resources across two tasks. This task required the subjects to make two responses per stimulus sentence by apportioning their attention to semantic judgements (T1) and lexical decisions (T2) following five prescribed T1/T2 response priority conditions (i.e. 0/100 %, 25/75 %, 50/50 %, 75/25 %, 100/0 %). Only non-stressed targets and sentences were used, since the purpose was to assess the trading relation between two tasks not complicated by emphatic stress. Only accurate response times for the two targets (T1n and T2n) were analysed. The criterion for passing this preliminary task was that across the five response priority conditions, the response time for correct responses to T1n (T1n RT) had to decrease and the response time for correct responses to T2n (T2n RT) had to increase. Such a pattern would reflect the way in which each subject was instructed to divide effort between the two tasks. Performance operating curves (POCs) were generated in order to depict the overall group relationship between the two targets over the five conditions. Consequently, all results or conclusions from task C of this study were based on and generalizable only to the control and aphasic subjects who demonstrated the preliminary effects of task A and task B. One potential control subject was eliminated on the basis of task A, and one aphasic and one control subject were eliminated on the basis of task B.

Result

Control subjects

Preliminary tasks A and B

The group response times for preliminary task A are summarized in Figure 1, while group POCs generated from task B are summarized in Figure 2.

Experimental task C

The response times for making lexical decisions when preceded by a non-stressed semantic judgement (T2 : T1n) were compared to the response times for making lexical decisions when preceded by emphatically stressed semantic judgements (T2 : T1s). Each subject's mean RT scores for T1n, T1s, T2 : T1n, and T2 : T1s were subjected to a one-way repeated-measures ANOVA. Significant differences were detected with $F(7, 88) = 43{\cdot}9, p < 0{\cdot}0001$. These data, representing the influence of emphatic stress applied to T1 on T1 judgements, as well as the influence of emphatic stress upon T2 decisions, are illustrated in Figure 3. *Post-hoc* comparisons using the Student–Newman–Keuls multiple-comparison procedure revealed several significant comparisons regarding the effects of emphatic stress applied to T1 on both T1 and T2 performance. Response times for making emphatically stressed semantic judgements (T1s) ($M = 1175$ ms, SD = 88 ms) were significantly less than non-stressed semantic judgements (T1n) ($M = 1327$ ms, SD = 89 ms) ($p < 0{\cdot}05$, $q = 5{\cdot}22$). This directional difference was evident in 11 of the 12 control subjects. *Post-hoc* Student–Newman–Keuls comparisons revealed that group response times for making lexical decisions when preceded by emphatically stressed T1 segments ($M = 1465$ ms, SD = 122 ms) were significantly greater than the response times for making lexical decisions when preceded by non-stressed T1 segments ($M = 1221$ ms, SD = 68 ms) ($p < 0{\cdot}05$, $q = 8{\cdot}39$). This indicated that

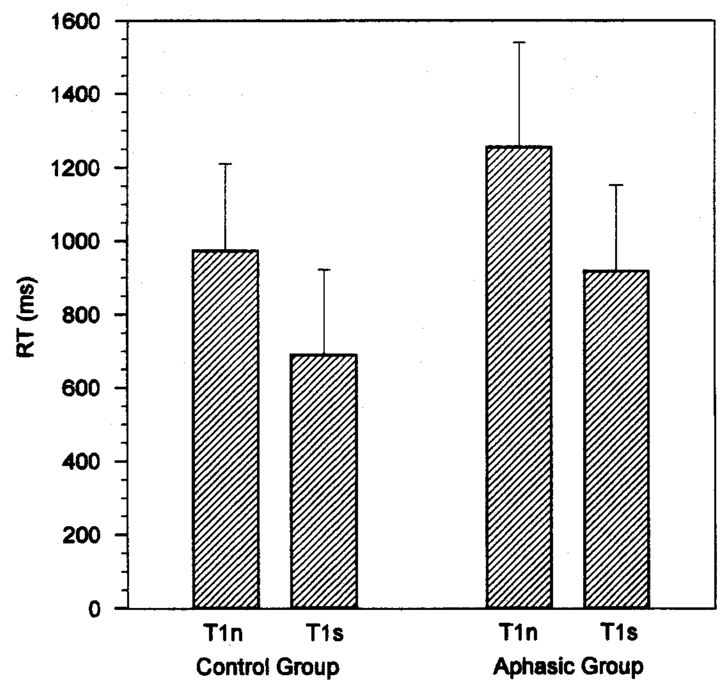

Figure 1. Task A: response time (RT) for T1n and T1s for both subject groups.

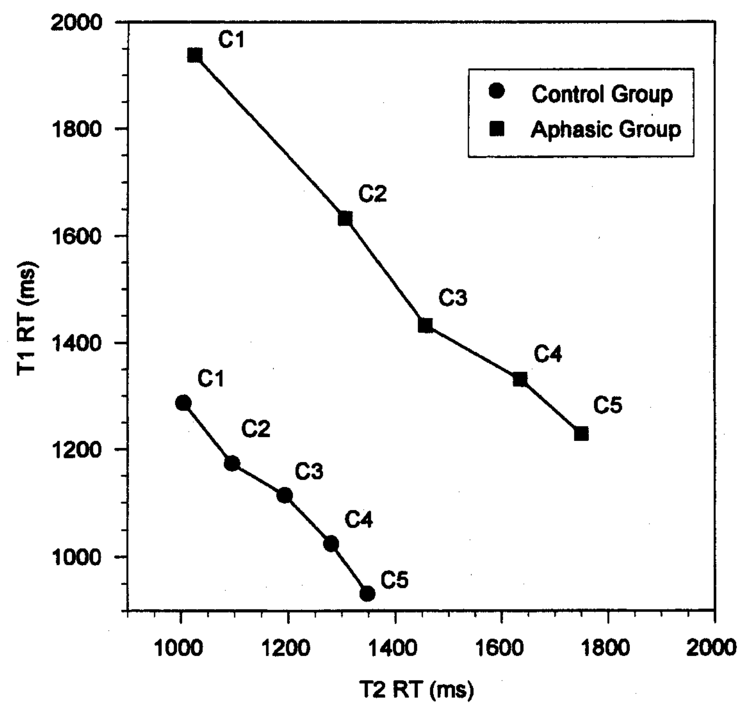

Figure 2. Task B: group performance operating curves (POCs) across five response priority conditions (C1–C5) for both subject groups.

although T1 performance improved with emphatic stress, lexical decision performance (T2) deteriorated when preceded by an emphatically stressed target (T1s). The response time results obtained in this experiment with these control subjects demonstrated that the faster responses to the emphatically stressed semantic judgements (T1s) resulted in slower lexical decisions (T2). Each control subject's performance was consistent with the group findings.

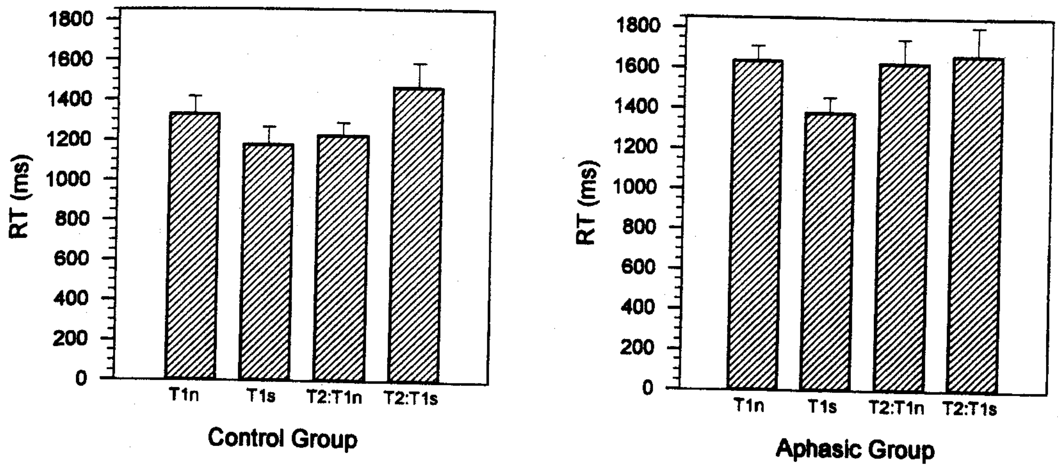

Figure 3. Task C: response time (RT) for T1n, T1s, T2:T1n, and T2:T1s for both subject groups.

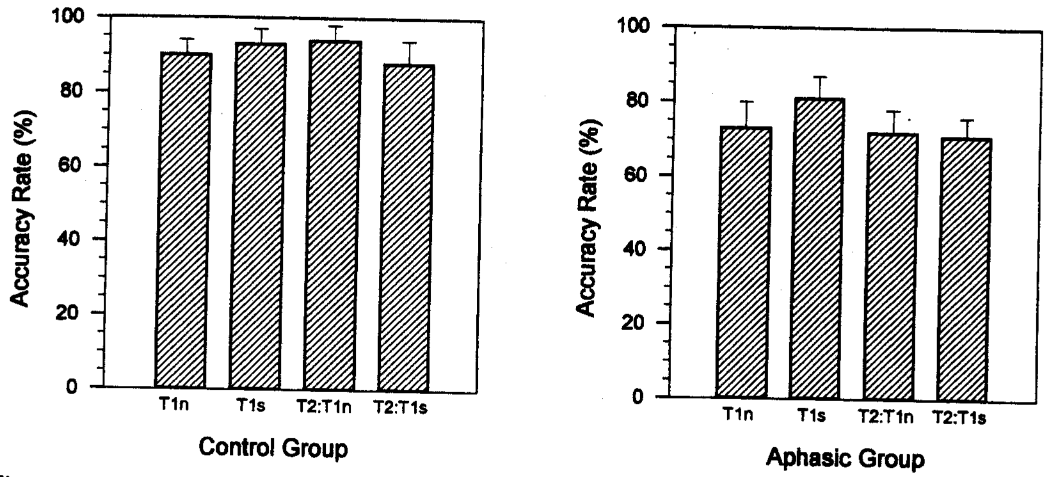

Figure 4. Task C: accuracy rate (AR) for T1n, T1s, T2:T1n, and T2:T1s for both subject groups.

The following results were obtained for accuracy rate (AR) data and are illustrated in Figure 4. A one-way repeated-measures ANOVA detected significant differences in mean accuracy rates with $F(3, 33) = 4{\cdot}77$, $p = 0{\cdot}007$. For the control subjects the mean accuracy rate for the non-stressed semantic judgements (T1n) was 0·90 (SD = 0·04) as compared to 0·94 (SD = 0·04) for the emphatically stressed semantic judgements (T1s). *Post-hoc* Student–Newman–Keuls multiple comparisons indicated that this difference was not significant ($p > 0{\cdot}05$, $q = 2{\cdot}76$), suggesting that semantic judgement response accuracy was unaffected by the emphatic stress applied to those stimuli. Of the 12 subjects, nine demonstrated greater accuracy for T1s over T1n, two demonstrated reduced accuracy for T1s relative to T1n, and one subject showed no difference.

Further analyses focused on the effects of emphatic stress on subsequent processing in dual-task conditions. The mean accuracy rate for making lexical decisions when preceded by non-stressed semantic judgements (T2:T1n) was 0·95 (SD = 0·04), as opposed to the mean accuracy rate of 0·89 (SD = 0·06) for lexical decisions when preceded by emphatically stressed semantic judgements (T2:T1s). In this case the *post-hoc* comparisons revealed a significant difference ($p < 0{\cdot}05$, $q = 4{\cdot}58$). Therefore, in this dual task, accuracy for making lexical decisions decreased when emphatic stress was applied to the preceding semantic judgement target. Of the 12 subjects, eight showed greater accuracy for the non-stressed condition, three showed greater accuracy for the stressed condition, and one demonstrated no difference in T2 performance regardless of the stressed/non-stressed condition of T1.

The following results were obtained for the response bias (B) and discrimination (d') data. A one-way repeated-measures ANOVA failed to detect significant differences in mean response bias for T1n, T1s, T2:T1n, or T2:T1s with $F(3, 33) = 2{\cdot}56$, $p = 0{\cdot}07$. For these control subjects the mean response bias for the non-stressed semantic judgements (T1n) was 0·95 (SD = 0·05) as compared to 0·99 (SD = 0·07) for the emphatically stressed semantic judgements (T1s). The mean response bias for T2:T1n was 0·99 (SD = 0·05) as compared to 1·01 (SD = 0·06) for T2:T1s. Therefore, these subjects did not exhibit an increased tendency to make positive or yes responses as compared to negative or no responses. An additional one-way repeated-measures ANOVA failed to detect significant differences in discrimination (d') for the semantic judgements and lexical decisions for T1n, T1s, T2:T1n, or T2:T1s with $F(3, 33) = 0{\cdot}67$, $p = 0{\cdot}10$. The mean discrimination for the non-stressed semantic judgements (T1n) was 1·66 (SD = 0·79) as compared to 1·78 (SD = 0·83) for the emphatically stressed semantic judgements (T1s). The mean discrimination for T2:T1n was 1·72 (SD = 1·05) as compared to 1·63 (SD = 0·85) for T2:T1s.

Aphasic subjects

Preliminary tasks A and B

The group response time data for task A and the group POCs generated for task B are summarized in Figures 1 and 2.

Experimental task C

The aphasic subjects' mean RT scores for T1n, T1s, T2:T1n, and T2:T1s were subjected to a one-way repeated-measures ANOVA. This analysis revealed a significant difference with $F(3, 33) = 23{\cdot}8$, $p < 0{\cdot}001$. These data are illustrated in Figure 3. *Post-hoc* Student–Newman–Keuls multiple comparisons of group response times to emphatically stressed semantic judgements (T1s) ($M = 1379$ ms, SD = 75 ms) were significantly less than the response times to non-stressed semantic judgements (T1n) ($M = 1634$ ms, SD = 74 ms) ($p < 0{\cdot}05$, $q = 8{\cdot}78$). All 12 aphasic subjects demonstrated this same directional difference.

As with the control group, additional comparisons were made between the response times for making lexical decisions when preceded by emphatically stressed semantic judgements (T2:T1s) and response times for making lexical decisions when preceded by non-stressed semantic judgements (T2:T1n). The aphasic subjects' RT data for T2:T1n and T2:T1s are also illustrated in Figure 3. Group mean RT data for T2:T1n equalled 1628 ms (SD = 121 ms) and group mean RT data for T2:T1s equalled 1666 ms (SD = 142 ms). *Post-hoc* comparisons using the Student–Newman–Keuls multiple-comparison procedure revealed no significant difference between the T2:T1n and T2:T1s conditions for the aphasic group ($p > 0{\cdot}05$, $q = 1{\cdot}31$). Six of the 12 subjects with aphasia demonstrated slower T2 RTs and six demonstrated faster T2 RTs.

For subjects with aphasia, a one-way repeated-measures ANOVA detected significant differences in mean accuracy rates for both the T1 and T2 stimuli in the stressed and non-stressed conditions with $F(3,33) = 6{\cdot}07$, $p = 0{\cdot}002$. *Post-hoc* comparisons indicated that the difference between T1n ($M = 0{\cdot}73$, SD $= 0{\cdot}07$) and T1s ($M = 0{\cdot}82$, SD $= 0{\cdot}07$) was significant ($p < 0{\cdot}05$, $q = 4{\cdot}42$). Therefore, response accuracy increased when emphatic stress was applied to the semantic judgement stimuli (see Figure 4). Ten of the 12 subjects showed improved accuracy for T1s over T1n and accuracy decreased for two subjects.

Further analyses (Figure 4) focused on the effects of emphatic stress on subsequent processing in these dual tasks. *Post-hoc* comparisons revealed no significant difference between the accuracy rates for T2:T1n ($M = 0{\cdot}72$, SD $=$ $0{\cdot}06$) and T2:T1s ($M = 0{\cdot}71$, SD $= 0{\cdot}06$) conditions for the aphasic group ($p >$ $0{\cdot}05$, $q = 0{\cdot}51$). Six of the 12 subjects showed an improvement in accuracy, while six showed a decrease in accuracy.

The following results were obtained for the response bias (B) and discrimination (d') data. A one-way repeated-measures ANOVA across T1 and T2 stressed and non-stressed conditions failed to detect significant differences in mean response bias for T1n ($M = 1{\cdot}01$, SD $= 0{\cdot}07$), T1s ($M = 0{\cdot}99$, SD $= 0{\cdot}06$), T2:T1n ($M =$ $0{\cdot}99$, SD $= 0{\cdot}10$), or T2:T1s ($M = 0{\cdot}99$, SD $= 0{\cdot}06$) with $F(3,33) = 0{\cdot}41$, $p =$ $0{\cdot}07$.

An additional one-way repeated-measures ANOVA failed to detect significant differences in discrimination (d') for the semantic judgements and lexical decisions T1n ($M = 1{\cdot}46$, SD $= 1{\cdot}04$), T1s ($M = 1{\cdot}54$, SD $= 0{\cdot}98$), T2:T1n ($M = 1{\cdot}32$, SD $= 0{\cdot}88$), and T2:T1s ($M = 1{\cdot}47$, SD $= 0{\cdot}93$) with $F(3,33) = 0{\cdot}41$, $p = 0{\cdot}07$ across stressed and non-stressed conditions.

Discussion

Emphatic stress applied to T1 resulted in significantly improved processing for both control and aphasic subject groups using these experimental tasks. However, important differences were observed in the effects of those improvements on subsequent processing in this dual-response task. When emphatic stress was applied to T1, T2 performance deteriorated for the control group. As predicted, a performance trade-off was demonstrated between the semantic judgement task and the lexical decision task. The general pattern of interference between the semantic judgement and the lexical decision tasks under the stressed and non-stressed conditions is consistent with expectations from a limited capacity resource allocation theory (Kahneman and Treisman 1984), as well as capacity limitations explicit in theories of working memory and activation (Just and Carpenter 1992). According to Kahneman and Treisman, as tasks vary in complexity or overall demands, activation for performing that task is likewise increased. If task demands increase to the point that they require most of the available resources, performance on concurrent computations or processing, as measured by response time and accuracy, is adversely affected (e.g. Just and Carpenter 1992, Tompkins *et al.* 1994). That is, the responses become slower, less accurate, or both. The control subjects' performance in this study revealed both slower and less accurate T2 responses when emphatic stress was applied to T1. Applying Just and Carpenter's notion of working memory for linguistic computations, the performance observed in this control group on this combined semantic judgement and lexical decision task may be attributed either to the way in which the available operating resources are redistributed following the emphatic stress, or to a reduced storage capacity for maintaining computational results (i.e. partial products) for subsequent interpretation. The result is that comprehending and responding to the semantic judgement task may approach capacity limitations, thereby availing fewer resources for ongoing comprehending and responding to the lexical decision task. Adding emphatic stress to the sentences increases the overall demands; therefore, with fewer resources available, these control subjects experienced more difficulty processing the stimuli of the second task. We interpret the slower and less accurate T2 responses in these individuals to be the result of processing inefficiency, similar to proposed mechanisms for the syntactic comprehension impairments discussed by Haarmann and Kolk (1991). Their interpretation is that the inefficiency is the result of an overload in the ability to process temporal demands of the incoming information, and not the result of a loss of function.

The results obtained by the aphasic subjects had a somewhat different pattern from the control subjects. In task C, semantic judgements (T1) made by individuals with aphasia were significantly faster and more accurate when the targets were emphatically stressed. In aphasic subjects the prosodic characteristics of the stimuli were manipulated sufficiently to change the saliency of the information presented. As found with the control subjects, these individuals with aphasia were sensitive to the acoustic properties that differentiated the emphatically stressed from the non-stressed stimuli (i.e. T1s vs. T1n) and were shown to share processing resources between the two tasks. However, for the aphasic subjects, lexical decision performance (T2) was not differentially affected by the presence of emphatic stress applied to T1, as it was for the control subjects. This finding of no significant difference between T2:T1n and T2:T1s may be explained in several ways.

The lack of differences might be attributed to the combination of two concurrent and opposing factors. Although a performance trade-off may have occurred, perhaps the aphasic subject's increased activation for the emphatically stressed T1 continued into the T2 decision-making process. Therefore, the influence exerted by one factor may have essentially negated the influence exerted by the other factor. The implications are that these individuals with aphasia may have experienced difficulty in the appropriate deactivation of salient stimuli, while simultaneously having fewer resources available for processing T2.

An alternative explanation appeals to the construct of working memory, which suggests that these subject groups processed the stimuli differently across the emphatically stressed and normally stressed conditions. The subjects with aphasia may have been unable to maintain the activations required for processing, storing, and responding to the two linguistic tasks with equal facility. Therefore, the simultaneous task demands may have exceeded the processing capacity for the aphasic subjects. In order to facilitate improved working memory and thereby maximize performance, they may have chunked or simplified the dual task into two or more independent tasks.

Another factor that may have contributed to the differential performance by the aphasic group involved the way in which subjects were requested to allocate their effort (Tseng *et al.* 1993). Throughout the five conditions for task B, the subjects were provided very explicit instructions regarding the effort that they were to allocate to performing each of the tasks. In task B a trade-off in performance was clearly evident. However, task C provided no direct or explicit instructions regarding how to allocate effort to perform the task. Although the emphatically stressed semantic judgements resulted in faster processing, it may have been that the absence of explicit instructions for differentially allocating effort across the semantic judgement and the lexical decision failed to initiate a sharing of processing resources.

Given the disparate findings between the control and aphasic subjects' performance on the experimental task, subsequent investigations will further explicate the acoustic characteristics of emphatically stressed stimuli and the temporal parameters involving dual-task linguistic processing. Until these data are replicated, and these subsequent experiments are conducted, a simple processing resource account for the beneficial effects of emphatic stress on the comprehension of aphasic individuals appears improbable.

Acknowledgements

This investigation was conducted as a doctoral dissertation by the first author and was supported in part through a Department of Veterans Affairs predoctoral fellowship in speech–language pathology. The authors wish to thank Patrick J. Doyle, Director, Aphasia Rehabilitation Research Laboratory, Highland Drive VA Medical Center, Pittsburgh, and staff for their assistance with this project. Appreciation is also extended to the dissertation committee composed of Drs Jean Chapman, Raymond Karlovich, Raymond Kent, and Dolores Vetter from the University of Wisconsin–Madison.

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Appendix: Semantic targets (ST), semantic distractors (SD), lexical targets (LT), and lexical distractors (LD)

Number	Animals ST	Animals SD	Clothing ST	Clothing SD	LT	LD
01	deer	swing	robe	sword	grape	brel
02	mouse	gum	glove	toast	plow	lurb
03	bear	soap	tie	blade	nail	ders
04	sheep	drum	shirt	lock	fork	narse
05	cat	plate	boot	jet	tank	doik
06	cow	stem	belt	sand	smoke	skib
07	snake	dust	coat	gate	pill	kidge
08	bird	knife	shoes	star	stone	chalp
09	dog	sign	dress	band	chair	plass
10	horse	stage	hat	desk	club	glape