Hemispheres in conflict:
When the left is mad, but the right is sad.

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Abstract

The two cerebral hemispheres have distinct processing strengths. However, almost any task calls on the skills of both hemispheres. In this thesis, I explore the integration of left- and right-hemisphere processes in speech perception. Previous research has demonstrated that the left hemisphere is specialized for processing the linguistic aspects of speech, and that the right hemisphere is specialized for processing prosody, or information that is carried in the tone of voice. The present series of experiments used an interference paradigm in which the linguistic content of the stimulus conflicted with the tone of voice in which it was spoken. Two theortetical viewpoints were considered. According to the shielding hypothesis, the fact that linguistic and prosodic processes are carried out in opposite hemispheres should minimize the interference between them. However, an alternative view is that there is a bilateral speech processing module with a specialized callosal relay channel to maximize integration (and therefore interference) between the two dimensions. These hypotheses were tested in a series of four experiments.

The first two experiments were designed to demonstrate that the stimuli met two criteria - linguistic and prosodic dimensions were processed in opposite hemispheres, and they produced interference. Experiments 3 and 4 used dichotic listening techniques to compare interference within a hemisphere to interference between hemispheres. Results from both experiments were incompatible with the shielding hypothesis, and the results from Experiment 4 were consistent with the specialized callosal relay hypothesis, in that interference was greater across hemispheres than within hemisphere.

In summary, the findings are consistent with the hypothesis that there is a specialized callosal relay channel between linguistic processing centres in the left hemisphere and prosodic processing centres in the right hemisphere. In the present study, this bilateral processing system maximized interference between linguistic and prosodic processes. However, in most speech processing situations, linguistic and prosodic information is congruent. The bilateral processing system would therefore lead to highly efficient integration of both dimensions.

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To Phil

1934 - 1996

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Introduction

The two cerebral hemispheres have long been known to be specialized for different processes. Early research on laterality focused on each hemisphere in isolation, through the study of patients with unilateral brain damage (Broca, 1861) or callosal disconnection (Sperry, 1974). Experimental techniques such as dichotic listening and visual half-field presentation were developed and refined to produce functional isolation in the intact brain - at least for a few milliseconds (Bryden, 1982). Catalogues of left- and right-hemisphere skills were developed: the left hemisphere is specialized for language, temporal processing, and praxis; the right for emotion, music, and spatial ability (see Hellige, 1993, for a review).

The catalogue approach assumed that the left and right hemispheres are specialized for different *tasks*. It has since become apparent that the two hemispheres may be specialized for different processes, but that many different processes contribute to the performance of any task. Although some processes may be completely lateralized (e.g., phonological processing appears to be restricted to the left hemisphere), other processes may exhibit only relative specialization to one hemisphere. The question then becomes: how do the hemispheres accomplish their division of labour, and how do they coordinate their resources?

Division of Labour in the Hemispheres

There are two possible approaches to the division of labour across hemispheres. The first is a division of processing based on *division of input*. For example, in the visual modality, the left visual field (LVF) projects to the right hemisphere, and the right visual field (RVF) projects to the left hemisphere. Each hemisphere may therefore process the information with which it is presented, and then provide its products for integration. Banich and colleagues have tested this hypothesis in their studies of the bilateral advantage (see Banich, in press, for a review). In a typical experiment (Banich & Belger, 1990), subjects compared a lateralized target stimulus to two probe stimuli - one in the same visual field and one in the opposite visual field. When the comparison is simple (e.g., Does the target have the same identity as either probe?) there is an advantage for within - hemisphere processing. However, when the task becomes more complex (e.g., Does the target plus one of the probes sum to a number greater than 10?) there is an advantage for cross - hemisphere processing. The bilateral advantage has been interpreted in terms of an increase in resources (in terms of neural space) when processing can be divided across hemispheres. There is some cost associated with the integration stage, but when the task is complex, the costs of integration are offset by the benefits of parallel processing.

According to this bilateral processing approach, the hemispheres divide processing according to stimulus input. However, it is assumed that each hemisphere performs the same *type* of processing. Another way that the hemispheres can share processing is for each to *process the same input in qualitatively different ways*. For example, given that our view of the world is not tachistoscopic, each hemisphere has equal access to the whole visual scene (at least in central vision). However, the left hemisphere is specialized for the processing of local information whereas the right is specialized for the processing of global information (Lamb, Robertson, & Knight, 1989; Martin, 1979; Sergent, 1983). Each hemisphere therefore performs different (possibly parallel) computations on the same input. At some point, local and global analyses are integrated to produce a unified percept .

It is likely that a similar division of labour occurs in the processing of speech input. Although left-hemisphere specialization for language is a central tenet of neuropsychological theory, it has been demonstrated that the left hemisphere is specialized for processing linguistic aspects of language (phonology, semantics, syntax) but that the right hemisphere is specialized for the processing of pragmatic aspects, especially prosody (information that is carried in the tone of voice). For example, patients with right-hemisphere damage (particularly in right parieto-temporal areas) are impaired in their judgment of the emotional prosody of sentences (Heilman, Scholes, & Watson, 1975; Tucker, Watson, & Heilman, 1977). A similar dissociation can be observed in normals.

Ley and Bryden (1982) presented dichotic sentences spoken in emotional tones of voice, and had subjects make decisions about either the meaning or the tone of voice. For the linguistic task, a right ear advantage (REA) was observed, reflecting left-hemisphere specialization, whereas for the prosodic task, a left ear advantage (LEA) was observed, reflecting right-hemisphere specialization. This finding suggests that each hemisphere processes the same stimulus in a qualitatively different way.

The lateralization of linguistic and prosodic processing to opposite hemispheres is referred to as a complementary pattern. Bryden and MacRae (1989) found that complementarity of linguistic and prosodic processing could also be observed with single words. They used the words "bower", "dower", "tower", and "power", spoken in tones of voice that were *mad*, *sad*, *glad*, and *neutral*. Stimuli were presented dichotically, such that there was a different word in a different tone of voice at each ear on each trial. In the linguistic task, subjects listened for a target word; in the prosodic task they listened for a target tone of voice. As expected, an REA was observed for the linguistic task, and an LEA was observed for the prosodic task.

In this thesis I will examine the integration of linguistic and prosodic information in speech perception. Given that these two dimensions of speech are processed primarily in opposite hemispheres, an examination of their interaction may serve to elucidate more general principles of interhemispheric integration. Integration of linguistic and prosodic information will be examined using a Stroop-like interference paradigm in which the linguistic meaning of words can conflict with the prosodic voice in which they are spoken.

In a standard Stroop experiment, subjects are required to identify the ink colour in which colour words are written (MacLeod, 1991; Stroop, 1935). Stimuli can be either congruent, incongruent, or neutral with respect to the relationship between ink colour and word. The typical finding is interference on incongruent trials relative to the neutral condition, and (less consistently) facilitation on congruent trials. The Stroop effect is asymmetric, that is, words interfere with the ability to identify ink colour, but ink colour does not generally interfere with the ability to name words. Most theoretical accounts of the Stroop effect suggest that interference arises at a response selection stage. The word sometimes enters the response selection mechanism first, either because it is processed faster (Morton & Chambers, 1973; Posner & Snyder, 1975) or automatically (Dunbar & MacLeod, 1988; Stroop, 1935), or because it is more strongly associated with the response (Cohen, Dunbar, & McLelland, 1990).

The stimuli for this series of experiments are the words "mad", "sad", "glad", and "fad", spoken in tones of voice that are *mad, sad, glad*, or *neutral.* Stimuli are therefore congruent, incongruent, or neutral with respect to the relationship between linguistic and prosodic information. The experiments are designed to examine the interference (and therefore the integration) of these components when the dimensions can be processed across hemispheres versus when they are processed in the same hemisphere. It is assumed that, under binaural conditions, each hemisphere has equal access to both dimensions, so each hemisphere processes the stimulus according to its own strengths. Dichotic manipulations are used to examine interference that occurs within a single hemisphere. Experiments 1 and 2 demonstrate that the two dimensions are processed in opposite hemispheres, and that they do interfere with each other. Experiments 3 and 4 use dichotic presentation to compare interference between and within hemispheres.

Models of Dichotic Listening Performance

The interpretation of results from a dichotic listening experiment depends on the model of dichotic listening performance that is assumed. In a typical dichotic listening experiment, competing stimuli are presented to each ear simultaneously. The auditory system is configured such that there are both contralateral and ipsilateral pathways from each ear to auditory cortex. However, it is thought that the ipsilateral pathways are suppressed under dichotic conditions, producing solely contralateral projection (Kimura, 1967). This structural model can be contrasted with attentional models of dichotic listening performance. For example, Kinsbourne (1975) proposed that the act of engaging in a verbal task activates the left hemisphere, and produces a bias toward the right ear. Similarly, engaging in a nonverbal (e.g., spatial) task leads to activation of the right hemisphere, and a leftward bias. Although attentional factors can clearly contribute to the production of perceptual asymmetries (Mondor & Bryden, 1992) there is compelling anatomical evidence for the structural model of performance, based on findings with split-brain patients who can verbally report the left ear stimulus under monaural conditions, but not under dichotic conditions. (Clarke, David, & Zaidel, 1993; Kimura, 1967).

When subjects engage in verbal processing in a dichotic listening task, an REA is typically observed. However, even if one assumes a structural model of performance, there are a number of ways in which the REA might arise. Zaidel (1995) distinguishes between direct access (in which stimuli are processed in the hemisphere to which they are projected, regardless of hemispheric specialization) and callosal relay (in which stimuli must be relayed to the appropriate hemisphere for processing). According to the direct access account, the REA reflects the inferior linguistic capabilities of the right hemisphere, which must process the left ear stimulus. Alternatively, the REA could reflect the delay (and possible degradation) that occurs when the left ear stimulus must be relayed to the left hemisphere. If one wishes only to determine which hemisphere is specialized for a specific process, the distinction between direct access and callosal relay is irrelevant. However, if one wishes to draw conclusions about the locus of processing with dichotic presentation, these models need to be made explicit.

With respect to the present experiments, in which stimuli have both linguistic and prosodic information, there are three possibilities for the locus of processing that is produced by dichotic presentation. These are illustrated schematically in Figure 1.

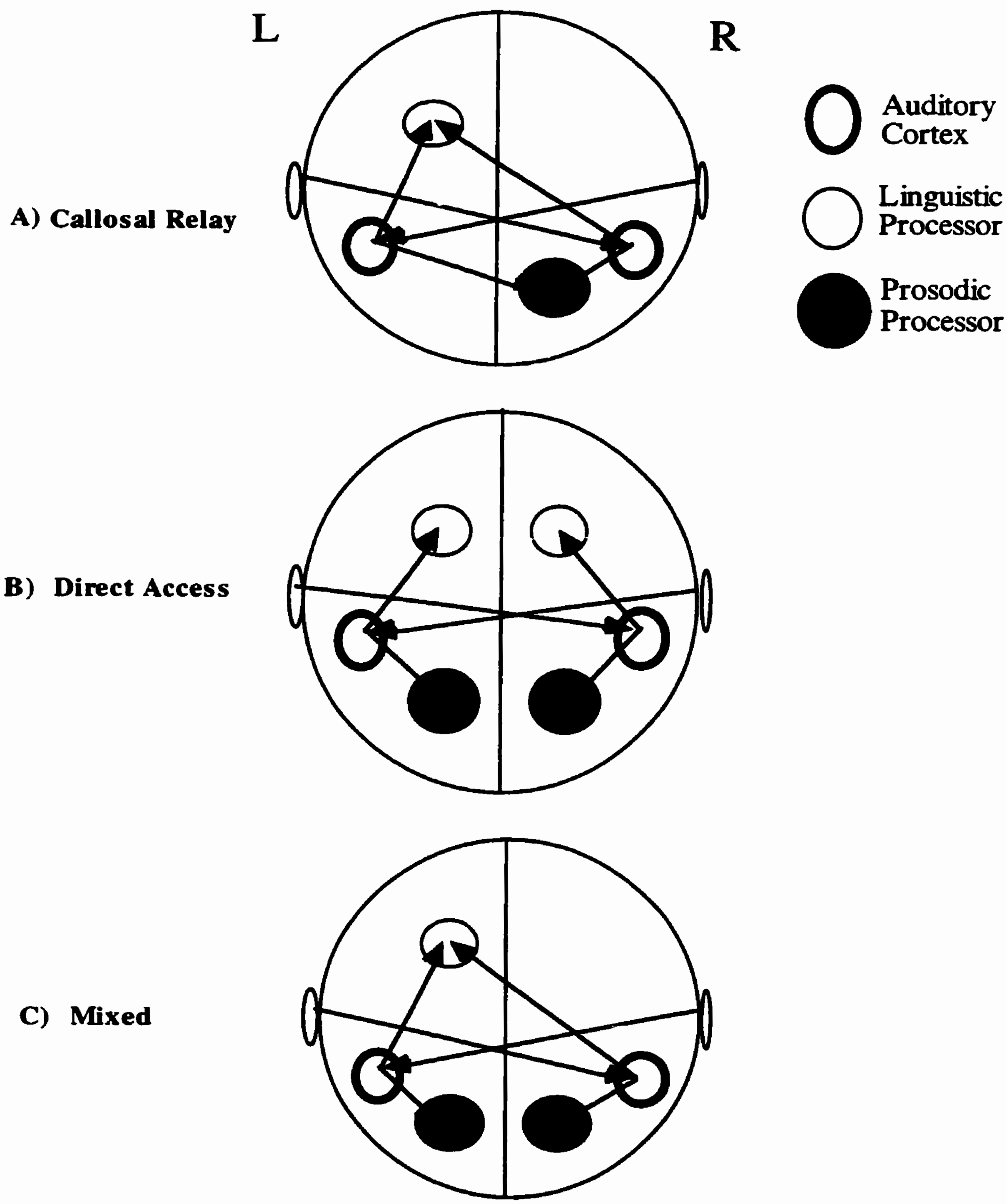

Figure 1

Models of dichotic listening performance. Under the mixed model, there is direct access for prosodic processing, but callosal relay for linguistic processing. Placement of modules within hemispheres is schematic, and does not reflect anatomical localization.

A) *Callosal relay for both linguistic and prosodic information* Regardless of the ear of presentation, linguistic information is processed in the left hemisphere, and prosodic information is processed in the right hemisphere. Therefore linguistic information must be relayed from the left ear stimulus, and prosodic information must be relayed from the right ear stimulus. Both dichotic and binaural conditions therefore produce processing across hemispheres. The callosal relay model is based on the premise of absolute specialization, in that the operations of left and right hemispheres are mutually exclusive. All-or-none models of hemispheric specialization are not well-accepted, and so this possibility will be eliminated in future discussion.

B) *Direct access for both dimensions* For the right ear stimulus, both linguistic and prosodic dimensions are processed in the left hemisphere, and for the left ear stimulus, both dimensions are processed in the right hemisphere. Dichotic presentation therefore produces within-hemisphere processing.

C) *Callosal relay for linguistic information, and direct access for prosodic information.* Direct access and callosal relay are not competing hypotheses, and they are not mutually exclusive. It is possible that the hemispheres process according to direct access if possible (e.g., prosodic processing), but resort to callosal relay for phonological processing. Consistent with this hypothesis is the finding that lateralization of prosody is not as strong or as consistent as that for phonological processing (Bryden & MacRae, 1989; Grimshaw, Bryden, & Finegan, 1994; Ley & Bryden, 1982). Studies of clinical populations also point to some capacity for prosodic judgment in the left hemisphere (Bowers et al., 1987). but little or no capacity for phonological processing in the right hemisphere (Zaidel & Peters, 1981). This model may be particularly appropriate when subjects are attending to the prosodic content of the stimulus, and linguistic information is unattended. According to this model, right ear presentation produces processing within the left hemisphere, but left ear presentation produces cross-hemisphere processing.

Theories of Interhemispheric Integration

There are two theoretical perspectives that predict different relations between lateralization of linguistic and prosodic processes and the interference between them. Each is based on differing viewpoints of the role of the corpus callosum and other commissures in interhemispheric interaction (see Chiarello & Maxfield, 1996, for a review of these and other models of interhemispheric inhibition).

The corpus callosum is the largest fibre tract in the human brain, consisting of approximately 200 million fibres (Aboitiz, Scheibel, Fisher, & Zaidel, 1992), ranging in size from very small, unmyelinated axons (less than 2 μm) to gigantic, myelinated axons (larger than 3 μm). Callosal fibres connect mainly homologous areas of cortex. Primary sensory areas are connected by large, fast fibres, whereas association areas are connected by small, slow fibres. The callosum is therefore highly heterogeneous, and it has been proposed that there are callosal channels (distinguished by topography, size, and speed) that serve different functions (Banich, 1995; Braun, Sapin-Leduc, Picard, Bonnefant, Achim, & Daigneault, 1994; Kinsbourne, 1995). It is therefore not necessary for callosal function to be uniform in all situations. There are also a number of subcortical commissures that can convey limited types of information.

The most traditional view of the role of the callosum in interhemispheric integration is that it acts as a shield to isolate each hemisphere from the other. More controversially, Robertson and colleagues (Lamb, Robertson, & Knight, 1989; Robertson, Lamb, & Zaidel, 1993) have proposed that the callosum acts as a specialized communication channel between component processes in left and right hemispheres. In the remainder of the introduction each theory will be reviewed and explicit predictions made about the patterns of interference that should be observed between linguistic and prosodic processes in this series of studies.

The Shielding Hypothesis

According to the shielding hypothesis, the corpus callosum is a gate that protects each hemisphere from the other, permitting independent and parallel processing. Of course, the gate must open (at some late stage of processing) to allow the integration of left- and right-hemisphere computations. This hypothesis has its roots in Kinsbourne and Hicks' (1978) Functional Cerebral Distance Hypothesis, which states that the interference between two tasks is inversely proportional to the functional distance between the anatomical substrates that subserve those tasks, and that points in opposite hemispheres are maximally distant. This premise was formalized by Friedman and Polson (1981), who claimed that the two hemispheres have independent and mutually inaccessible pools of resources (but see Pashler & O'Brien, 1993). Therefore, two processes that are completed entirely in opposite hemispheres should not interfere with each other. Recall from Figure 1 that, according to the direct access model, presentation to each ear produces within-hemisphere processing (and therefore interference). According to the mixed model, right-ear presentation should produce interference, but left-ear presentation, which produces cross-hemisphere processing, should not produce interference.

The shielding hypothesis has been used with some success for the localization of cognitive function using dual task methodology. For example, concurrent verbal activity affects right finger-tapping more than left finger-tapping, whereas concurrent spatial processing affects left finger-tapping more than right finger-tapping (Hiscock, 1982). Similarly, verbal memory for nonsense syllables is better during left finger-tapping than during right finger-tapping (Friedman, Polson, & Dafoe, 1988).

Shielding is assumed in the explanation of the bilateral advantage described above (Banich, in press). Recall that the bilateral advantage is proposed to result from the increase in resources that are available when processing can be divided across hemispheres, following the assumption that the hemispheres have independent resource pools. Each hemisphere is presumed to process its input in an independent and parallel fashion.

However, Chiarello and Maxfield (1996) have argued that, although callosal shielding is implied in the explanation of the bilateral effect, it is not a necessary conclusion on the basis of the data. Indeed, an advantage for cross-hemisphere processing may reflect more efficient connectivity (and integration) across hemispheres than within hemispheres.

Findings about the lateralization of the Stroop effect are mixed, but they provide limited support for the shielding hypothesis. The primary prediction of the shielding hypothesis is that interference should be greater within a hemisphere than across hemispheres. This hypothesis has been tested using a paradigm in which the word and colour patch are spatially separated, and performance is compared for bilateral versus unilateral presentation (note that the interpretation of results from these experiments makes the implicit assumption of direct access for both word reading and colour naming with lateralized visual presentation). Several experimenters have used this paradigm and found greater interference for unilateral versus bilateral presentation (David, 1992; Zaidel, 1994) although others have observed no differences (Weekes & Zaidel, 1996; Shenker, Dori & Banich, 1994).

A corollary of the shielding hypothesis is that the pattern of interference within a hemisphere will be influenced by hemispheric specialization. Specifically, greater Stroop interference should be observed in the verbally oriented left hemisphere than in the nonverbal right hemisphere (assuming that colour naming can be performed by either hemisphere). This hypothesis has been confirmed in a number of studies using lateralized presentation of Stroop stimuli (Guiard, 1981; Hugdahl & Franzon, 1985; Schmitt & Davis, 1974). To the extent that the stimuli in the present series of experiments are Stroop-like, one might predict similar results. Specifically, one might expect more linguistic interference in the left hemisphere, and more prosodic interference in the right hemisphere. Predictions from the shielding hypothesis are outlined in Table 1.

Specialized Callosal Channels

An alternative to the shielding hypothesis comes from Robertson and colleagues (Lamb, Robertson, & Knight, 1990; Robertson, Lamb, & Zaidel, 1993), who suggest that the callosum does not reduce interference, it causes it. Their hypothesis is specific to the integration of global and local information in visual processing. There is considerable evidence that the left hemisphere is specialized for the processing of local information, and the right hemisphere is specialized for the processing of global information. For example, when copying a hierarchical stimulus (e.g., a large letter "S" made of small letter "T"s), patients with left hemisphere damage (particularly in areas of the temporo-parietal junction) will draw the global letter but not its local elements, whereas patients with damage in homologous areas of the right hemisphere will draw the local elements, but not arrange them into an appropriate global configuration (Delis, Robertson, & Efron, 1986; Robertson & Lamb, 1991). Studies of split-brain patients indicate that hemispheric specialization reflects a processing bias toward global or local levels, and not absolute lateralization of processing (Robertson, Lamb, & Zaidel, 1993). All three split-brain patients tested by Robertson et al. were able to make global judgments (identifying the global letter of hierarchical stimuli) of stimuli presented to the left hemisphere, and two of three were able to make local judgments of stimuli presented to the right hemisphere.

In normal subjects, global information interferes with local processing (Navon, 1977), a phenomenon known as global interference. Interestingly, both in patients with unilateral damage to temporo-parietal junction (T-P; Lamb, Robertson, & Knight, 1989, 1990) and in split-brain patients (Robertson et al., 1993), global interference is absent. In a series of 12 patients with unilateral T-P damage (5 left hemisphere and 7 right hemisphere), Robertson et al. (1990) found that left T-P damage produced very long responses to local information (250 ms global advantage versus a 30 ms global advantage in normals), but no global interference. In the studies of the three split-brain patients (Robertson et al., 1993), hierarchical stimuli were presented unilaterally. Patients identified the global or local letters in separate blocks. When stimuli were presented to the right hemisphere, RTs for global identification were similar to those for controls, but RTs for local identification were much slower (300 - 400 ms). None the less, none of the subjects demonstrated global interference, and in fact, two of the three exhibited slightly longer RTs when information at global and local levels was congruent than when it was incongruent. When stimuli were presented bilaterally, so that each hemisphere could process according to its own processing strengths, global interference was still absent. This finding suggests that it is interhemispheric communication that produces global interference. The effect is specific to the processing of global and local information, and does not represent some generalized ability to inhibit unattended information. For example, these same patients still exhibit normal Stroop interference (Henik, Lamb, & Robertson, 1993, cited in Robertson, 1995).

This pattern of results is highly counter-intuitive, especially given our often implicit acceptance of the hemispheric shielding view of interhemispheric interaction. However, Robertson and colleagues argue that it reflects the operation of a highly efficient bilateral system that integrates global and local analyses to produce unified visual perception. Global/local integration is therefore a desirable product of visual processing, and it is only under the artificially contrived situation in which global and local analyses conflict that interference arises. A specialized communication channel is proposed to connect homologous areas of T-P cortex. When this channel is disrupted, either through callosal disconnection or unilateral damage, global and local levels of analysis can no longer interact, and global interference is no longer observed.

Robertson's results might also be conceptualized in terms of differing mechanisms of selection across versus within hemispheres. Given that each hemisphere can process at either the global or local level, early selection mechanisms within a hemisphere must bias processing toward one level, and eliminate the possibility of interference between levels.

However, across hemispheres, global and local analyses run in parallel, leading to late selection of one dimension, and the potential for interference.

Although Robertson's hypothesis is specific to the integration of global and local information in visual processing, it is possible that a similar bilateral system operates for the integration of linguistic and prosodic information in speech perception. If so, maximal interference between linguistic and prosodic information would be expected when processing is divided across hemispheres. According to a direct access model of dichotic listening, no interference would be expected with dichotic presentation to either ear, as this produces processing of both dimensions within the same hemisphere According to the mixed model, one would expect interference with presentation to the left ear (as this produces cross-hemisphere processing) but not with presentation to the right ear (as both dimensions are then processed in the left hemisphere). This pattern might be particularly evident when subjects are attending to the prosodic dimension, as this is the situation in which callosal relay of linguistic information is most likely. These predictions are outlined in Table 1.

Experiments 1 and 2 establish that the stimuli used in this series of experiments meet two criteria: First, the linguistic and prosodic dimensions are processed in opposite hemispheres and second, they interfere with each other. Experiments 3 and 4 examine interference that occurs under dichotic conditions, in order to examine interference within and across hemispheres.

Table 1

Predicted patterns of interference on linguistic and prosodic tasks.

	Model of Dichotic Listening	
Theory	Direct Access	Mixed
Shielding		
Linguistic Task	L > R	R > L
Prosodic Task	R > L	R > L
Callosal Channel		
Linguistic Task	L = R = 0	L > R
Prosodic Task	L = R = 0	L > R

Note: Each cell depicts the relative magnitude of interference from the opposite dimension.

L = Left Ear, R = Right Ear.

EXPERIMENT 1

Experiment 1 was designed to determine if the linguistic and prosodic dimensions of the stimuli are processed in opposite hemispheres. It employed a target detection procedure similar to that in Bryden and MacRae (1989). Stimuli were presented dichotically, and subjects attended to a linguistic target in one block, and a prosodic target in another block. It was expected that an REA would be observed on the linguistic task, and an LEA would be observed on the prosodic task.

Method

Participants

Participants were 32 right-handed undergraduate students (16 men and 16 women). All spoke English as a first language, or learned English before the age of 5. None had any history of audiological problems. They received either course credit or payment for their participation.

Stimuli and Apparatus

Stimuli for this and all other experiments were the words "mad", "sad", "glad" and "fad", spoken in emotional tones of voice that were *mad*, *sad*, *glad*, or *neutral*. Words were spoken in a female voice and digitized in 16 bits at a sampling rate of 44.1 kHz on a PowerMacintosh 7100AV computer, using SoundEdit 16 software. Individual speech tokens were edited to include 30 ms of silence prior to the onset of the initial burst, and were truncated if necessary at 750 ms. Four samples of each token were initially recorded, for a total of 64 tokens. These tokens were then presented binaurally in random sequence to four raters who were required to identify the emotional tone of voice without time pressure. On the basis of these ratings, one sample of each token was selected for which the emotional tone had been identified with 100% accuracy. Tokens were then combined in all possible pairings, with the constraint that a different word and a different tone of voice were presented to each ear on each trial. This produced 144 stimulus pairs. The experiment was presented on a PowerMacintosh 7100AV computer equipped with a 15 inch AV monitor through JVC headphones with circumaural cushions. PsyScope software was used to control the experiment (Cohen, MacWhinney, Flatt, & Provost, 1993). The same computer apparatus was used for all five experiments.

Procedure

Participants attended to a linguistic target and a prosodic target in separate blocks. Initially, they heard each of the 16 tokens presented once binaurally, and they were required to indicate if their target was present or absent, using the index fingers of the left and right hands on the [z] and [/] keys of the computer keyboard. Participants then proceeded to the dichotic trials. They were instructed to indicate whether their target was present in either ear, or absent. Targets were present on 50% of the trials, half in the left ear and half in the right ear. Participants were instructed to respond as quickly and as accurately as possible, and response time (RT) was recorded. They then proceeded to their second target, repeating the binaural practice trials and then the experimental dichotic trials. Subjects performed 2 blocks of 72 trials for each task, for a total of 288 trials. Earphones were reversed between the first and second blocks of each instructional condition to control for mechanical effects. Each possible target combination was assigned to two subjects (1 man and 1 woman). Task order and response hand for present versus absent trials were counterbalanced across subjects. The experiment took approximately 30 minutes to complete.

Results and Discussion

Mean response times for correct responses were calculated for each condition. Outliers were identified using a simple recursive outlier procedure with a criterion of 3 standard deviations (Van Selst & Jolicoeur, 1994). Fewer than 1% of data points were excluded on this basis. Mean RTs and error rates (misses) are presented in Figure 2.

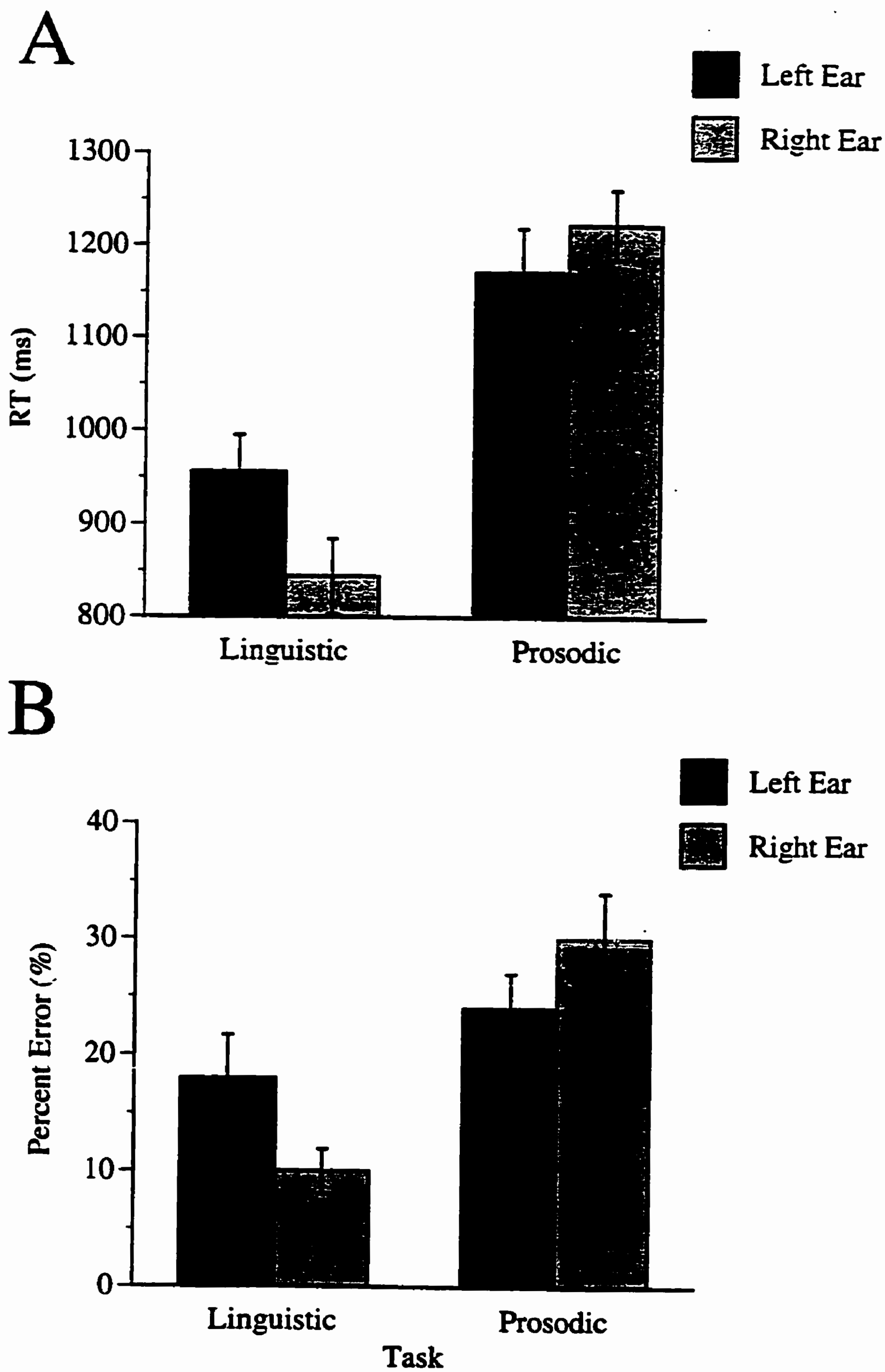

Figure 2. Experiment 1: Response times (A) and error rates (B) for the detection of linguistic and prosodic targets as a function of ear.

Response Times

RTs for present trials were analyzed in a 2 (Task) x 2 (Ear) x 2 (Sex) x 2 (Response Hand) analysis of variance (ANOVA) with Task and Ear as within-subjects variables, and Sex and Response Hand as between-subjects variables. No effects of Sex or Response Hand were observed, and so they were eliminated from the analyses. A main effect of Task was observed, $F(1, 31) = 28.50$, $p < .001$, reflecting faster responses for linguistic targets. Also, a Task x Ear interaction was observed, $F(1, 31) = 4.44$, $p < .05$. Planned comparisons of the ear advantage for each task revealed a significant REA of 112 ms for the linguistic task, $t\,(31) = 3.52$, $p = .001$, and a nonsignificant LEA of 52 ms for the prosodic task, $t(31) = -0.95$, *ns* (see Figure 2).

Error Rates

Error rates for present trials (misses) were analyzed in a similar manner. The main effect of Task was again observed, $F\,(1, 31) = 14.68$, $p = .001$, as was the Task x Ear interaction, $F(1, 31) = 10.98$, $p = .002$. A significant REA was observed for the linguistic task, $t(31) = 2.40$, $p = .02$ and a significant LEA was observed for the prosodic task, $t(31) = -2.06$, $p = .04$.

Experiment 1 clearly indicates that there is differential hemispheric specialization for the two dimensions of these stimuli, with linguistic information processed primarily in the left hemisphere, and prosodic information processed primarily in the right hemisphere. They are therefore good candidates for this study of interhemispheric integration. Although both the interaction of Task and Ear and the REA for linguistic targets were significant in both RT and error data, the LEA for prosodic targets was significant only in the error data. It should be noted that the LEA for prosodic information was smaller than the REA for linguistic information, a common finding in laterality studies, which may reflect some left-hemisphere competence for prosodic analysis.

EXPERIMENT 2

Experiment 2 consisted of a binaural identification task in which subjects identified either the word or the tone of voice of each stimulus. Although interference in the standard Stroop task is asymmetric, that is, words interfere with colour-naming, but colours do not interfere with word-naming, it was not clear what pattern of interference should be observed between linguistic and prosodic information. This experiment therefore identified the interference pattern that should be expected under standard binaural conditions.

Method

Participants

Participants were 24 right-handed undergraduate students (12 men and 12 women). All were either native speakers of English, or learned English before the age of 5. None reported any history of audiological problems. They received either course credit or payment for their participation.

Stimuli and Apparatus

The stimuli were the same auditory tokens used in Experiment 1, presented on the same computer system. Stimuli were either congruent (e.g., "mad" in a *mad* voice), incongruent (e.g., "mad" in a *glad* voice), or neutral. Neutral stimuli for the linguistic task were the words "mad", "sad", and "glad" spoken in a *neutral* tone of voice. Neutral stimuli for the prosodic task were the word "fad" spoken in *mad*, *sad*, and *glad* voices.

Procedure

Participants attended to either the tone of voice or the word in separate blocks. In the linguistic task, they identified the words "mad", "sad", and "glad" spoken in tones of voice that were *mad*, *sad*, *glad*, or *neutral*, using the three middle fingers of one hand on the [b], [n], and [m] keys of the computer keyboard. In the prosodic task, they identified the emotions *mad*, *sad*, and *glad*, carried by the words "mad", "sad", "glad" and "fad", using the same three fingers on the same keys. Each block of 72 experimental trials was proceeded by 36 neutral practice trials, that were designed to help subjects learn the response mapping. Equal numbers of congruent, incongruent and neutral trials were presented. Response hand and response mapping (6 possible configurations) were counterbalanced across subjects. The experiment took approximately 15 minutes to complete.

Results and Discussion

Response times for correct responses were subjected to a recursive outlier procedure using a criterion of 3 standard deviations (Van Selst & Jolicoeur, 1994). Fewer than 1% of data points were eliminated on this basis. Although both congruent, neutral, and incongruent stimuli were presented, only neutral and incongruent trials (i.e., interference) were analyzed. Because attention to either dimension on a congruent trial leads to the same response, it is impossible to know the source of any facilitation. Better performance on congruent than neutral trials may not reflect true cognitive facilitation, but might rather be an artifact produced by the participant occasionally responding to the wrong dimension (MacLeod & MacDonald, in press; Vanayan, 1992). Therefore, all analyses are based on only neutral and incongruent trials. All data for congruent trials (for this and all other experiments) are presented in the appendices.

Response Times

Mean response times for each condition are presented in Table 2. They were analyzed in a 2 (Task) x 2 (Congruency) x 2 (Response Hand) analysis of variance with Task and Congruency as within-subjects variables, and Response Hand as a between-subject variable. A main effect of Congruency, $F(1, 22) = 12.40, p = .002$ and a main effect of Task, $F(1, 22) = 22.52, p < .001$ were modulated by a Task x Congruency interaction, $F(1, 22) = 11.52, p = .003$. RTs were much shorter for the linguistic task than for the prosodic task. Interference effects were assessed for each task separately and are presented in Figure 3A. In this and in all experiments, interference is assessed

Table 2

Experiment 2: Response Times as a Function of Task and Congruency (n=24)

	Neutral		Incongruent		Interference	
Task	Mean	*S.D.*	Mean	*S.D.*	**Mean**	***S.D.***
Linguistic	763	*190*	795	*194*	**32 ***	***79***
Prosodic	920	*188*	1030	*236*	**110 ***	***137***

Note. Interference is measured as [Incongruent - Neutral]

* $p < .05$ (one-tailed)

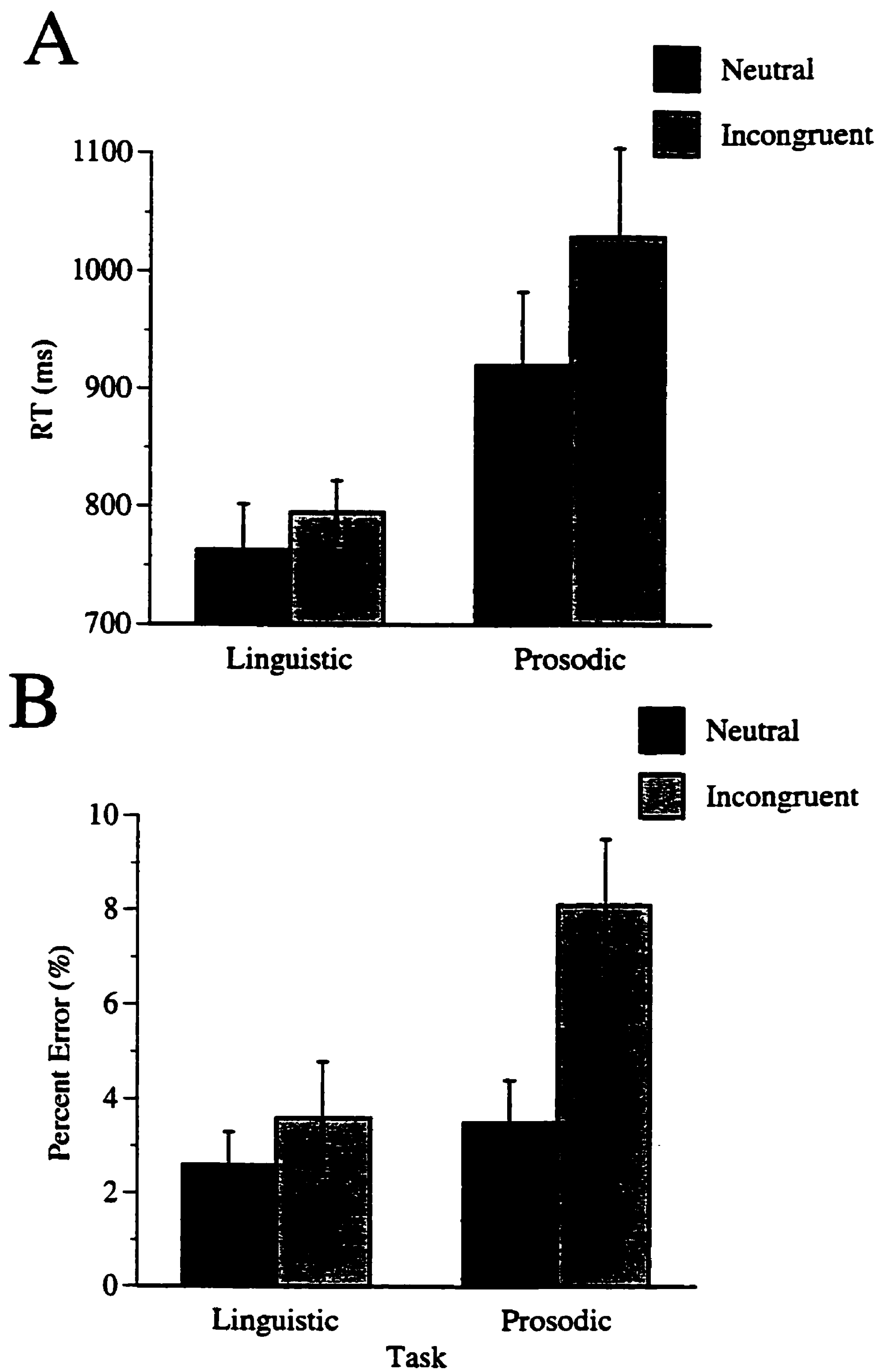

Figure 3. Experiment 2: Response times (A) and error rates (B) for the identification of linguistic and prosodic dimensions.

as the difference between incongruent and neutral trials. All statistical tests of interference effects are one-tailed, because, by definition, interference occurs when performance on incongruent trials is slower or less accurate than that on neutral trials. Significant interference was observed in both the prosodic $t(23) = 3.92$, $p < .001$ and lingustic tasks, $t(23) = 1.98$, $p = .03$.

Error Rates

Error rates are presented in Table 3, and were analyzed in a similar manner. Again, main effects of Congruency, $F(1, 22) = 8.46$, $p = .008$, and Task, $F(1, 22) = 7.17$, $p = .014$ were observed. Error rates were higher on the prosodic task than on the linguistic task. The Task x Congruency interaction that was observed in the RT data approached significance, $F(1, 22) = 3.93$, $p = .06$. Interference was significant in the prosodic task, $t(23) = 3.50$, $p = .001$, but not in the linguistic task, $t(23) = 0.40$, *ns*. Interference effects are presented in Figure 3B.

In summary, linguistic information produced a great deal of interference when subjects were identifying the prosodic content of the stimulus. Although mean RTs for the prosodic task were almost 200 ms slower than those for the linguistic task, prosodic information still produced significant but modest interference when subjects were identifying the linguistic content of the stimulus. This suggests that speed-of-processing cannot account entirely for the interference that is observed on the prosodic task, although a task that is, on average, slower can interfere with one that is, on average, faster, if there is some overlap in the response time distributions (MacLeod, 1991).

Table 3

Experiment 2: Percent Error as a Function of Task and Congruency (n=24)

Task	Neutral		Incongruent		Interference	
	Mean	*S.D.*	Mean	*S.D.*	**Mean**	***S.D.***
Linguistic	2.6	*3.4*	3.6	*6.1*	**1.0**	***6.3***
Prosodic	3.5	*4.5*	8.1	*7.0*	**4.6 ***	***6.5***

Note. Interference is measured as [Incongruent - Neutral]

* $p < .05$ (one-tailed)

The results of Experiments 1 and 2 together indicate that linguistic and prosodic dimensions of these Stroop-like stimuli are processed primarily in opposite hemispheres, and they interfere with each other. They are therefore excellent stimuli for the investigation of interhemispheric interference. Experiments 3 and 4 examine interference that is observed under binaural conditions, when hemispheres can divide processing according to their own strengths, and that observed under conditions of dichotic stimulation, when the stimulus is initially projected to only one hemisphere.

EXPERIMENT 3

Experiment 3 used dichotic presentation in order to examine interference when stimuli were initially projected to one hemisphere or the other. On a dichotic trial, the target stimulus was presented to one ear, and the *neutral* word "fad" was presented to the other ear. This distractor stimulus was required to produce dichotic presentation, and therefore maximize ipsilateral suppression. However, it provided no specific interference or facilitation for either the linguistic or prosodic dimension. Subjects identified the word or the tone of voice, and responded to the stimulus in the right ear or left ear in separate blocks.

Recall that the actual locus of processing with dichotic presentation is not known, but inferences depend on the model of dichotic listening that is assumed. Under direct access, both dimensions of the stimulus from the left ear are processed in the right hemisphere, and both dimensions of the stimulus from the right ear are processed in the left hemisphere. Both left- and right-ear presentation therefore produce within-hemisphere processing. The shielding hypothesis therefore predicts that interference will appear under dichotic conditions, and that linguistic interference will be greater in the right ear and prosodic interference will be greater in the left ear. In contrast, the callosal channel hypothesis predicts that interference will be eliminated under dichotic conditions. Under the mixed model, with callosal relay for linguistic information and direct access for prosodic information, linguistic information is always processed in the left hemisphere, but prosodic information is processed in the left hemisphere with right ear presentation, and in the right hemisphere with left ear presentation. Therefore right-ear presentation produces within-hemisphere processing, and left-ear presentation produces cross-hemisphere processing (see Figure 1). The shielding hypothesis therefore predicts greater interference at the right than at the left ear (regardless of task), and the callosal channel hypothesis predicts greater interference at the left than at the right ear.

Binaural trials, in which the target stimulus was presented to both ears, were mixed with the dichotic trials. Binaural trials served two purposes. First, they provided a baseline measure of interference that occurs when both hemispheres have equal access to all information, and can divide processing according to hemispheric specialization. Second, they allowed an examination of the effects of attending to either the left or right ear on the interference between linguistic and prosodic dimensions. It is assumed that dichotic presentation influences the locus of processing (according to the models described above), and therefore any differences between the ears reflect differences within or across hemispheres. However, it is also possible that attention to a single ear (especially over a block of trials) produces activation of the contralateral hemisphere (Kinsbourne, 1970). Therefore, attention to the right ear may bias performance toward linguistic processing, and attention to the left ear may bias performance toward prosodic processing. If so, different patterns of interference may be observed on binaural trials as a function of the direction of attention.

Method

Participants

Participants were 32 right-handed undergraduate students from the University of Waterloo. None reported a history of hearing problems, and all were either native speakers of English or learned English before the age of 5. They were paid for their participation.

Stimuli and Apparatus

Stimuli were the same as those described in Experiment 1. On dichotic trials, a target stimulus (congruent, neutral, or incongruent) was presented in the attended ear, and the *neutral* word "fad" was presented in the opposite ear. On binaural trials, the target stimulus was presented to each ear.

Procedure

Each task manipulation (linguistic or prosodic identification) was preceded by 36 binaural practice trials (to teach response mapping). Each task condition consisted of 4 blocks of 36 trials. Subjects attended to and reported from one ear in the first and fourth blocks, and from the other ear in the second and third blocks. Earphones were reversed after the second block to control for mechanical effects. Within blocks, one half of the trials were dichotic, and one half were binaural. Subjects identified the stimulus in the target ear as mad, sad, or glad, using the keys [b], [n], and [m], respectively. Half of the subjects responded with the middle three fingers of their left hands, and half with the middle three fingers of their right hands. Although it would have been desirable to balance response hand within subjects, the three-finger response mapping proved difficult to translate across hands. Orders of task and ear of report were also counterbalanced across subjects. The experiment took approximately 30 minutes to complete.

The design was a 2 Task (linguistic/prosodic) x 2 Congruency (neutral/incongruent) x 2 Presentation (dichotic/binaural) x 2 Attended Ear (left/right), x 2 Response Hand (left/right) factorial ANOVA with 12 trials per condition.

Results and Discussion

Response Times

RTs were subjected to a simple recursive outlier procedure on a cell by cell basis, with a criterion of 3 standard deviations (Van Selst & Jolicoeur, 1994). Fewer than 1% of the data points were excluded on this basis. Mean RTs are presented in Table 4. Interference effects are presented in Figures 4A (linguistic task) and 5A (prosodic task). Because of the large number of comparisons associated with a 5-way design, analyses were carried out to test specific hypotheses. First, the omnibus ANOVA is reported, for completeness. Then, interference effects are analyzed for binaural and dichotic conditions separately. The analysis of binaural trials was carried out to confirm that the typical pattern of interference (as demonstrated in Experiment 2) was still observed, and to determine whether directed attention itself influenced that pattern. Analysis of dichotic trials was planned to compare the magnitude of interference when the stimulus is presented to the left or right ear. This analysis is the test of the two hypotheses of interhemispheric interaction.

Table 4

Experiment 3: Response Times as a Function of Task, Congruency, Ear, and Response Hand

Task	Left Hand (n=16)						Right Hand (n=16)					
	Neutral		Incongruent		**Interference**		Neutral		Incongruent		**Interference**	
	Mean	*S.D.*	Mean	*S.D.*	**Mean**	***S.D.***	Mean	*S.D.*	Mean	*S.D.*	**Mean**	***S.D.***
Linguistic												
Left Ear	898	*280*	929	*329*	**31 ***	***71***	815	*133*	809	*119*	**-5**	***109***
Binaural	768	*91*	817	*141*	**49 ***	***92***	756	*146*	780	*115*	**24**	***57***
Right Ear	813	*150*	819	*127*	**6**	***87***	846	*174*	786	*128*	**-60**	***91***
Prosodic												
Left Ear	1082	*275*	1177	*270*	**95 ***	***178***	1082	*334*	1091	*247*	**10**	***177***
Binaural	1055	*268*	1099	*171*	**45**	***159***	958	*218*	1052	*258*	**94 ***	***115***
Right Ear	1113	*234*	1122	*173*	**9**	***198***	1065	*301*	1055	*250*	**-10**	***121***

Note. Interference is measured as [Incongruent-Neutral]

* $p < .05$ (one-tailed)

Omnibus ANOVA. Mean RTs were analyzed in a mixed analysis of variance with Task, Ear, Presentation and Congruency as within-subjects variables, and Response Hand as a between-subjects variable. Because of the large number of effects associated with a 5-way analysis, only significant effects will be reported here. The omnibus ANOVA revealed main effects of Task, $F(1, 30) = 63.05$, $p < .001$, Ear, $F(1, 30) = 4.22$, $p = .049$, Presentation, $F(1, 30) = 26.08$, $p < .001$, Congruency, $F(1, 30) = 10.27$, $p = .003$, and interactions of Type x Congruency, $F(1, 30) = 5.42$, $p = .027$, Hand x Task x Ear, $F(1, 30) = 4.47$, $p = .043$, and Hand x Task x Ear x Type x Congruency, $F(1, 30) = 4.37$, $p = .045$.

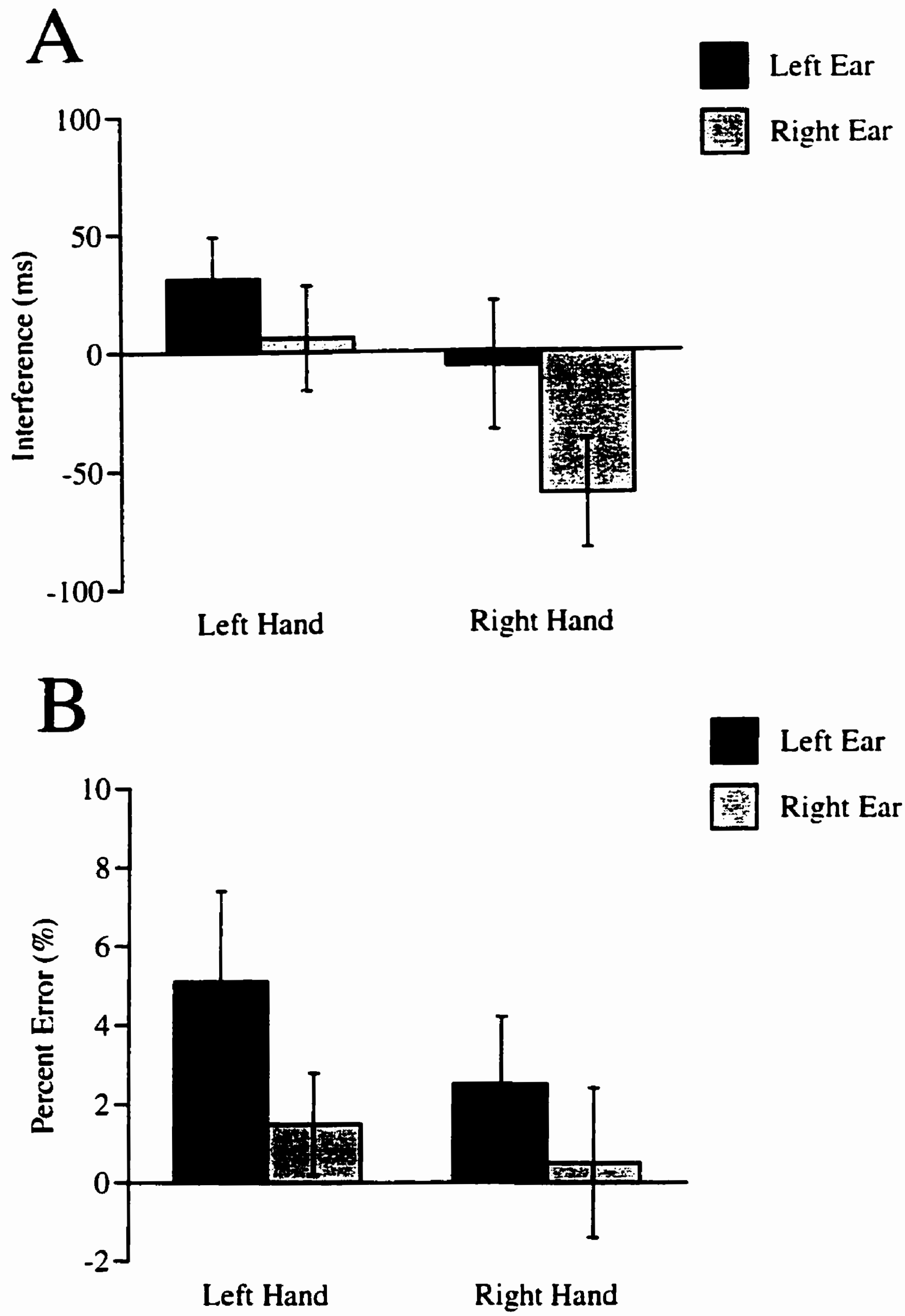

Figure 4. Experiment 3: Interference in ms (A) and % error (B) on the linguistic task as a function of ear and response hand. Interference = [Incongruent - Neutral].

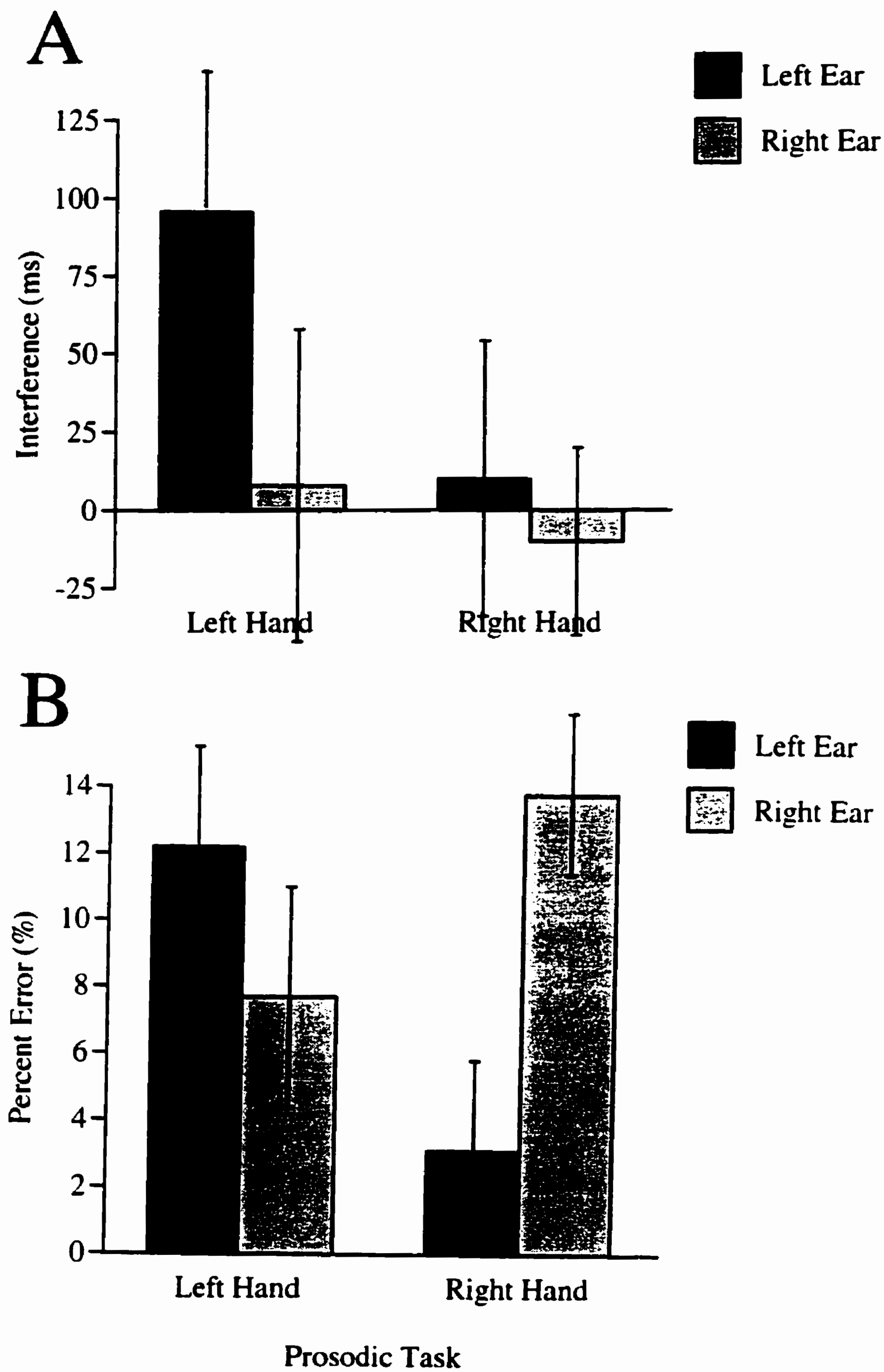

Figure 5. Experiment 3: Interference in ms (A) and % error (B) on the prosodic task as a function of ear and response hand. Interference = [Incongruent - Neutral].

Table 5

Experiment 3: Percent Error as a Function of Task, Congruency, Ear, and Response Hand

Task	Left Hand (n=16)						Right Hand (n=16)					
	Neutral		Incongruent		**Interference**		Neutral		Incongruent		**Interference**	
	Mean	*S.D.*	Mean	*S.D.*	**Mean**	***S.D.***	Mean	*S.D.*	Mean	*S.D.*	**Mean**	***S.D.***
Linguistic												
Left Ear	4.1	*12.5*	9.2	*18.7*	**5.1 ***	***9.3***	2.5	*4.8*	5.0	*6.4*	**2.5**	***7.0***
Binaural	1.0	*1.8*	1.8	*2.9*	**0.8**	***3.3***	1.8	*2.5*	1.0	*2.3*	**-0.8**	***3.6***
Right Ear	1.5	*3.2*	3.0	*5.0*	**1.5**	***5.2***	3.0	*5.0*	3.5	*5.0*	**0.5**	***7.4***
Prosodic												
Left Ear	4.0	*4.1*	16.2	*9.6*	**12.3 ***	***12.0***	5.5	*6.3*	8.6	*7.0*	**3.1**	***10.6***
Binaural	4.8	*4.9*	8.6	*7.0*	**3.8**	***9.1***	2.8	*3.8*	8.1	*5.8*	**5.3 ***	***6.7***
Right Ear	5.6	*9.3*	13.3	*11.3*	**7.7 ***	***13.4***	0.5	*2.0*	14.3	*10.3*	**13.8 ***	***9.5***

Note. Interference is measured as [Incongruent-Neutral]

* $p < .05$ (one-tailed)

Binaural Trials. In order to examine the effects of directed attention on binaural performance, a separate ANOVA was carried out for binaural trials. The results revealed the expected main effects of Task, $F(1, 30) = 57.01$, $p < .001$, and Congruency, $F(1, 30) = 15.28$, $p < .001$, as well as a main effect of Ear, $F(1, 30) = 5.57$, $p = .025$, which reflected faster response times when subjects were attending to the right ear. Importantly, this ear advantage did not interact with Task or Congruency. It is interesting to note that the Task x Congruency interaction did not approach significance, $F(1, 30) = 1.28$, $p = .266$, indicating that, in contrast to Experiment 2, equivalent interference was observed on linguistic and prosodic tasks. Overall, there was 37 ms of interference on the linguistic task, and 69 ms of interference on the prosodic task.

Dichotic Trials. Of greatest interest for the hypotheses is the comparison of interference effects at left and right ears under dichotic conditions. Therefore, an ANOVA was carried out on just dichotic trials. This analysis revealed only the expected main effect of Task, $F(1, 30) = 56.90$, $p < .001$. However, several interactions approached significance. The interaction of Hand and Congruency, $F(1, 30) = 3.72$, $p = .063$ reflected the fact that larger interference effects were observed with the left hand. This difference must be qualified by the inexplicable finding of 60 ms of facilitation (incongruent trials faster than neutral trials) on the linguistic task in the right ear of subjects who responded with the right hand. Most importantly, the interaction of Ear and Congruency, $F(1, 30) = 3.79$, $p = .061$, reflects greater interference overall in the left than in the right ear. This effect did not interact with Task.

In summary, greater interference was observed in the left ear than in the right ear, for both the linguistic and prosodic tasks. Furthermore, interference effects were larger in subjects who responded with the left hand. These findings cannot be reconciled with the shielding hypothesis of interhemispheric interaction. However, they are consistent with a callosal-channel account if one assumes the mixed model of dichotic-listening performance, in which direct access is observed for prosodic processing, but callosal relay is necessary for linguistic processing. According to this model, when stimuli are presented to the right ear, both linguistic and prosodic dimensions are processed in the left hemisphere. It is in this within-hemisphere condition that interference is eliminated. This pattern is particularly evident on the prosodic task (see Figure 5). The effect of response hand is also consistent with the callosal-channel interpretation. It is when subjects are responding with the left hand that prosodic processing is most likely to occur in the right hemisphere, as both processing and output factors are biased toward the right.

Error Rates

Omnibus ANOVA. Percent errors were similarly analyzed in a 5-way ANOVA, with Task, Ear, Presentation, and Congruency as within-subjects variables, and Response Hand as a between-subjects variable. Cell means are presented in Table 3, and interference effects are plotted in Figures 4B and 5B. The omnibus ANOVA revealed main effects of Task, $F(1, 30) = 48.15$, $p < .001$, Presentation, $F(1, 30) = 12.81$, $p < .001$, and Congruency, $F(1, 30) = 60.87$, $p < .001$, and a Type x Congruency interaction, $F(1, 30) = 9.94$, $p = .004$. These effects all mirrored those in the RT data. A Task x Congruency interaction, $F(1, 30) = 22.51$, $p < .001$ indicated that greater interference was observed on the prosodic than on the linguistic task.

An interaction of Hand x Ear x Congruency was observed, $F(1, 30) = 4.85$, $p = .035$. In general, interference effects were larger in the left ear in subjects who responded with the left hand, but were larger in the right ear of subjects who responded with the right hand. This effect interacted with Presentation, $F(1, 30) = 4.19$, $p = .05$, such that it was observed only on dichotic trials. This Hand x Ear interaction suggests that interference effects are larger when callosal relay is not necessary for response execution.

Binaural Trials. Analysis of the binaural trials revealed only the expected effects of Task, $F(1, 30) = 55.99$, $p < .001$, Congruency, $F(1, 30) = 7.07$, $p = .012$, and the Task x Congruency interaction, $F(1, 30) = 12.06$, $p = .002$. There were no main effects or interactions involving ear, indicating that directed attention did not influence accuracy in the binaural condition.

Dichotic Trials. Performance was compared on left- and right-ear dichotic trials. This analysis again revealed the effects of Task, $F(1, 30) = 16.59, p < .001$, Congruency, $F(1, 30) = 81.06, p < .001$, and the Task x Congruency interaction, $F(1, 30) = 12.96, p = .001$. There was an interaction of Hand x Ear x Congruency, $F(1, 30) = 7.00, p = .013$, and there was a trend for this effect to interact with Task, $F(1, 30) = 3.20, p = .084$. In subjects who responded with the left hand, there was more interference at the left than at the right ear on both the linguistic and prosodic tasks. This pattern is consistent with that observed in the RT data, and with that predicted by the callosal channel hypothesis. However, in subjects who responded with the right hand, there was more interference at the left than at the right ear on the linguistic task, but more interference at the right ear than at the left ear on the prosodic task.

The findings from the error data are not consistent with the shielding hypothesis of interhemispheric interaction. However, they are also less clearly supportive of the callosal channel hypothesis than are the RT data. The inconsistency between results in the RT and the error data in right-hand responders makes their data impossible to interpret. Experiment 4 was designed to resolve these issues.

EXPERIMENT 4

Experiment 4 was designed to provide converging evidence for the callosal channel hypothesis using a slightly different procedure to examine interference between linguistic and prosodic processes with binaural and dichotic presentation. Given the response hand interactions that were observed in Experiment 3, response hand was balanced within subjects. Additional practice trials were included whenever response hand changed, in order to help subjects adjust to the response mapping.

The design of Experiment 4 was similar to that of Experiment 3, except that ear of report was cued on a trial by trial basis with a tone presented in the target ear, 450 ms before the onset of the stimulus. This manipulation served two purposes. It allowed for a replication of the findings of Experiment 3 using a different manipulation, and it allowed ear of report to vary from trial to trial, so as to minimize any potential effects of attentional set such as specific hemispheric activation (Kinsbourne, 1975). Again, dichotic and binaural trials were mixed.

Method

Participants

Participants were 32 right-handed undergraduates from the University of Waterloo. None reported any history of hearing loss, and all were either native speakers of English, or learned English before the age of 5. Subjects were paid for their participation.

Stimuli and Apparatus

Speech stimuli and the computer apparatus were the same as those described in Experiment 1. On dichotic trials, the stimulus was presented to the target ear, and the *neutral* word "fad" was presented to the opposite ear. Ear of report was cued with a 1000 Hz pure tone, 100 ms in duration, presented at a stimulus onset asynchrony (SOA) of 450 ms. Binaural trials consisted of the identical stimulus in each ear. Binaural trials were also cued, although the cue was irrelevant for the purposes of report.

Procedure.

Each task manipulation (linguistic or prosodic identification) was preceded by 36 binaural practice trials (to teach response mapping). Each task condition consisted of 4 blocks of 60 trials. Subjects responded with one hand for the first and second blocks, and the other hand for the third and fourth blocks. Earphones were reversed after the first and third blocks to control for mechanical effects. Subjects performed 12 practice trials whenever response hand was changed. Within blocks, one half of the trials were dichotic, and one half were binaural, and half were cued to each ear. Subjects identified the stimulus in the target ear as mad, sad, or glad, using the keys [b], [n], and [m], respectively. Orders of task and initial response hand were counterbalanced across subjects. The experiment took approximately 40 minutes to complete.

The design was a 2 Task (linguistic/prosodic) x 2 Congruency (neutral/incongruent) x 2 Presentation (dichotic/binaural) x 2 Attended Ear (left/right), x 2 Response Hand (left/right) factorial ANOVA with 10 trials per condition.

Results and Discussion

RTs were subjected to a simple recursive outlier procedure on a cell by cell basis, with a criterion of 3 standard deviations (Van Selst & Jolicoeur, 1994). Fewer than 1% of data points were excluded on this basis. Analyses followed the same plan outlined in Experiment 3.

Response Times

Omnibus ANOVA. Mean RTs are presented in Table 6, and interference effects are presented in Figures 6A (linguistic task) and 7A (prosodic task). Results from the 5-way repeated measures ANOVA (Task x Ear x Presentation x Congruency x Response Hand) revealed effects of Task, $F(1, 30) = 97.31, p < .001$, Congruency, $F(1, 30) = 32.88, p < .001$, Task x Congruency, $F(1, 30) = 4.26, p = .048$, and Presentation, $F(1, 30) = 67.02, p < .001$. These effects were all consistent with those observed in Experiment 3. The Task x Congruency effect interacted with both Ear, $F(1, 30) = 11.40$, p

= .002 and Hand, $F(1, 30) = 4.28$, $p = .047$. The interaction with Ear indicated that there was greater interference when the cue was at the left ear than at the right ear, on the prosodic task, but greater at the right than the left ear on the linguistic task. A similar interaction was observed with Response Hand. Greater interference was observed when subjects were responding with the left than with the right hand, and again this effect was limited to the prosodic task.

Binaural Trials. Analysis of the binaural trials revealed no main effects or interactions involving Ear, suggesting that the lateralization of the tone cue did not affect processing on binaural trials.

Dichotic Trials. Interference at left and right ears was compared in a 2 (Task) x 2 (Ear) x 2 (Congruency) x 2 (Response Hand) ANOVA. This analysis revealed the expected main effect of Task, $F(1, 30) = 78.78$, $p < .001$, and a Task x Ear x Congruency interaction, $F(1, 30) = 6.47$, $p = .016$. This effect reflected greater interference at the left than in the right ear, but only on the prosodic task. This pattern of results is strikingly similar to that observed in Experiment 3, and is consistent with the callosal-channel account of interhemispheric interference, if one assumes the mixed model of dichotic-listening performance. According to this model, when the stimulus is in the right ear, both linguistic and prosodic dimensions are processed in the left hemisphere. It is under these conditions that interference is eliminated. Interference is greatest when the stimulus is in the left ear. Under these conditions, prosodic information is processed in the right hemisphere, and linguistic information is processed in the left hemisphere. Interference (and therefore integration) is maximal when the two dimensions are processed in opposite hemispheres. No interactions with response hand were observed.

Table 6

Experiment 4: Response Times as a Function of Task, Congruency, Ear, and Response Hand (n=32)

	Left Hand						Right Hand					
Task	Neutral		Incongruent		**Interference**		Neutral		Incongruent		**Interference**	
	Mean	*S.D.*	Mean	*S.D.*	**Mean**	***S.D.***	Mean	*S.D.*	Mean	*S.D.*	**Mean**	***S.D.***
Linguistic												
Left Ear	939	*360*	887	*190*	**-51**	***237***	873	*233*	891	*227*	**18**	***138***
Binaural	784	*166*	769	*170*	**-14**	***80***	740	*162*	803	*214*	**63 ***	***123***
Right Ear	849	*267*	867	*195*	**18**	***191***	839	*233*	878	*255*	**39**	***157***
Prosodic												
Left Ear	1113	*290*	1245	*274*	**133 ***	***120***	1157	*313*	1202	*262*	**44**	***231***
Binaural	1021	*228*	1107	*303*	**86 ***	***160***	1017	*259*	1081	*236*	**64 ***	***133***
Right Ear	1192	*359*	1195	*254*	**3**	***283***	1229	*534*	1219	*375*	**-10**	***388***

Note. Interference is measured as [Incongruent-Neutral]

* p < .05 (one-tailed)

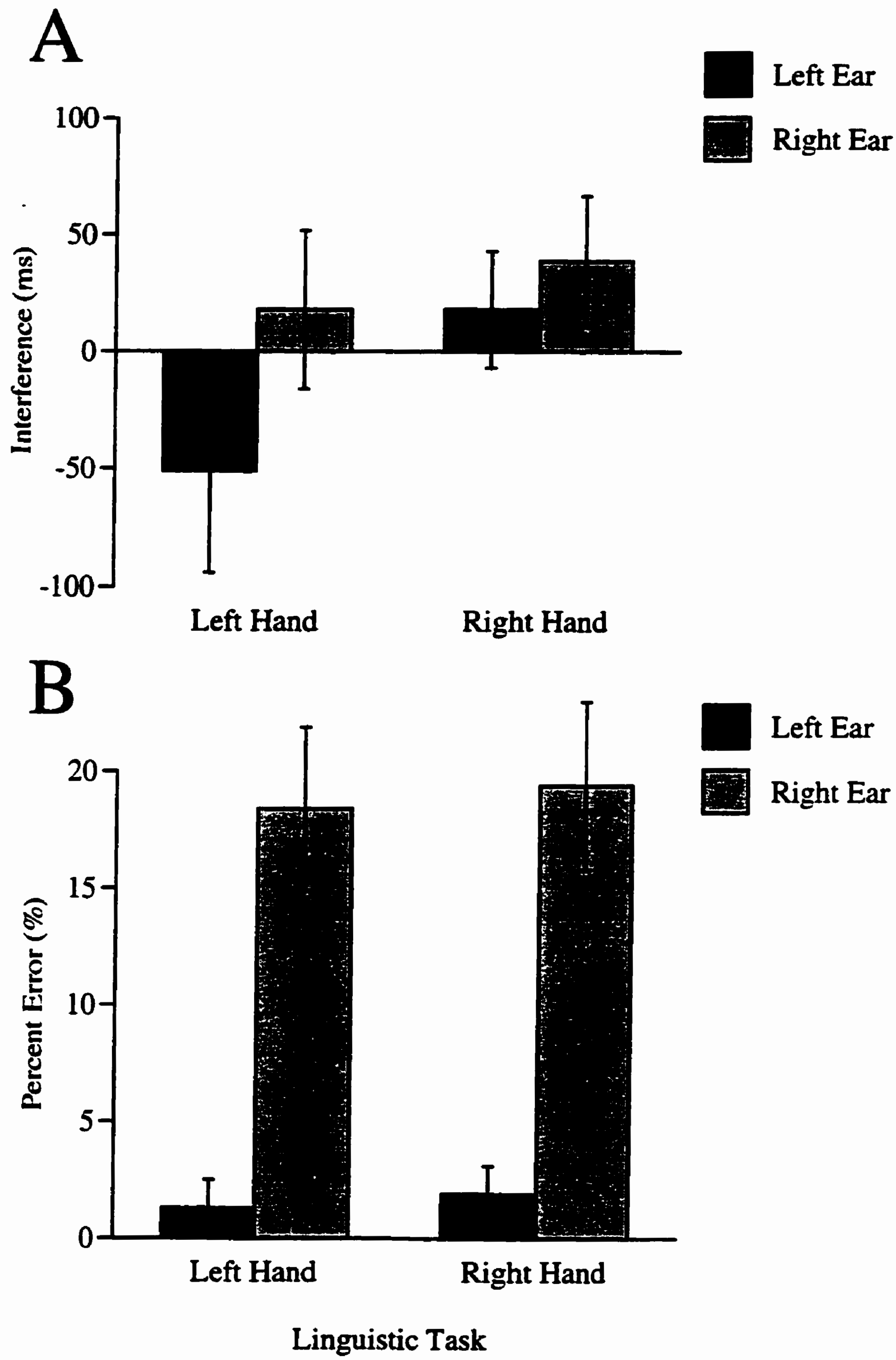

Figure 6. Experiment 4: Interference (in ms and % error) on the linguistic task as a function of ear and response hand. Interference = [Incongruent - Neutral].

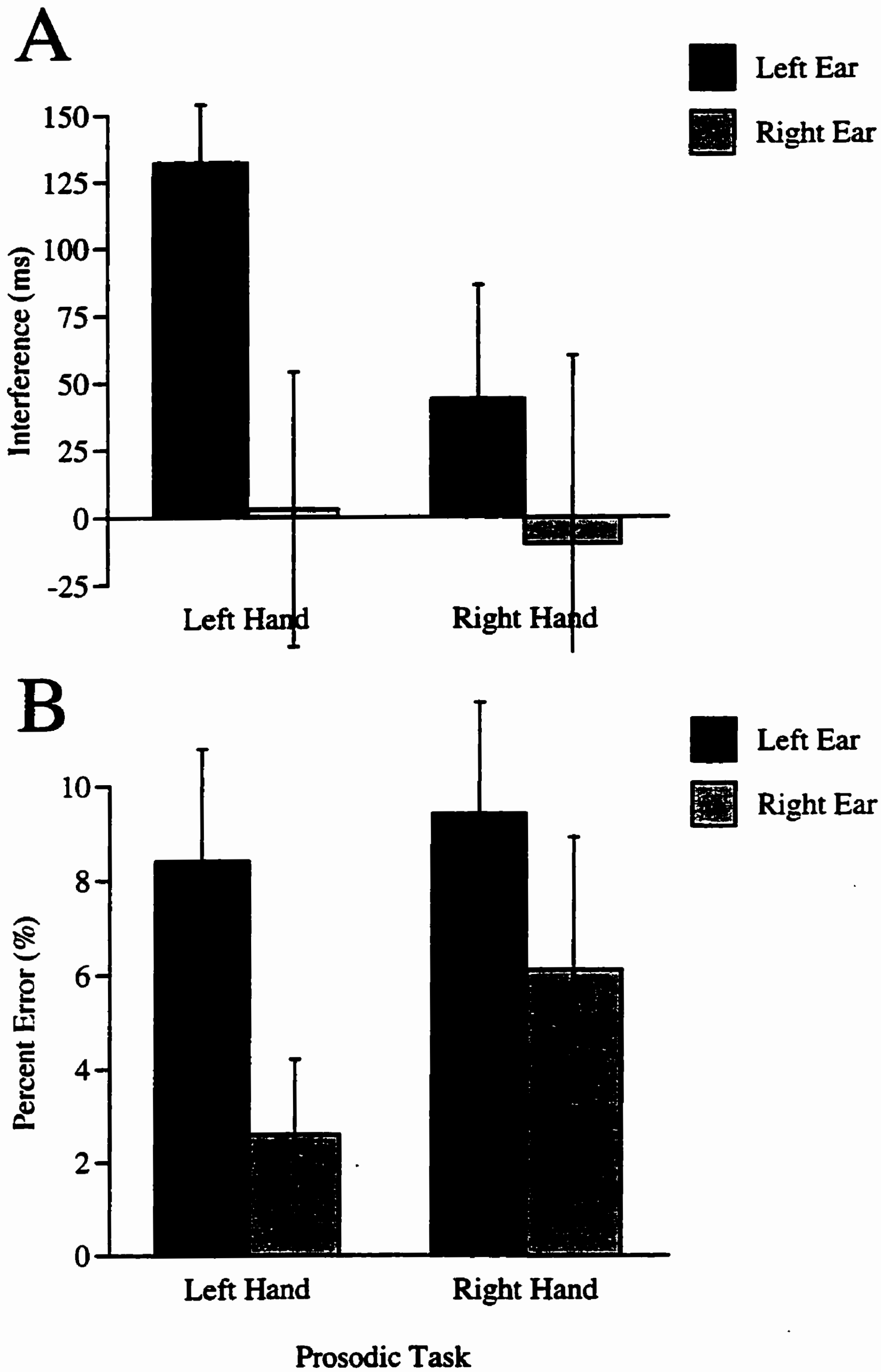

Figure 7. Experiment 4: Interference in ms (A) and % error (B) on the prosodic task as a function of ear and response hand. Interference = [Incongruent - Neutral].

Error Rates

Omnibus ANOVA. Mean error rates are presented in Table 7, and interference effects are plotted in Figures 6B (linguistic task) and 7B (prosodic task). The 5-way ANOVA revealed many significant effects. Effects were observed of Task, $F(1, 30) = 9.22$, $p = .005$, Ear, $F(1, 30) = 14.74$, $p = .001$, Presentation, $F(1, 30) = 71.65$, $p < .001$, Congruency, $F(1, 30) = 86.78$, $p < .001$, Task x Ear, $F(1, 30) = 13.90$, $p = .001$, Task x Presentation, $F(1, 30) = 9.19$, $p = .005$, Ear x Presentation, $F(1, 30) = 16.44$, $p < .001$, Ear x Congruency, $F(1, 30) = 12.76$, $p = .001$, Presentation x Congruency, $F(1, 30) = 30.42$, $p < .001$, Task x Ear x Presentation, $F(1, 30) = 15.24$, $p < .001$, Task x Ear x Congruency, $F(1, 30) = 18.56$, $p < .001$, Task x Presentation x Congruency, $F(1, 30) = 21.46$, $p < .001$, Ear x Presentation x Congruency, $F(1, 30)= 25.88$, $p < .001$, and Task x Ear x Presentation x Congruency, $F(1, 30) = 61.52$, $p < .001$.

Binaural Trials. Binaural trials were analyzed separately in order to assess the effects of left and right tone cues on interference. No main effects or interactions involving Ear were observed, indicating that accuracy on binaural trials did not vary as a function of the location of the tone cue.

Dichotic Trials. Dichotic trials were analyzed in order to compare interference when attending to the left and right ears. An Ear x Congruency interaction was observed, $F(1, 30) = 32.18$, $p < .001$ that further interacted with Task $F(1, 30) = 59.36$, $p < .001$. Interference was greater in the left ear than in the right ear, but only for the prosodic task. This pattern of results is again similar to that observed in Experiment 3, and is consistent with a callosal channel account of interhemispheric interference if one assumes direct access for prosodic processing, and callosal relay for linguistic processing. In contrast with Experiment 3, no interactions involving response hand were observed. Response hand interactions in Experiment 3 may therefore have reflected group differences, or may have been the result of using the same hand throughout the experiment.

Table 7

Experiment 4: Percent Error as a Function of Task, Congruency, Ear, and Response Hand (n=32)

Task	Left Hand						Right Hand					
	Neutral		Incongruent		**Interference**		Neutral		Incongruent		**Interference**	
	Mean	*S.D.*	Mean	*S.D.*	**Mean**	***S.D.***	Mean	*S.D.*	Mean	*S.D.*	**Mean**	***S.D.***
Linguistic												
Left Ear	3.9	*9.9*	5.2	*9.3*	**1.3**	***6.7***	2.6	*4.5*	4.5	*7.7*	**1.9**	***7.0***
Binaural	2.1	*4.6*	2.7	*4.0*	**0.6**	***5.1***	1.6	*4.9*	3.1	*4.8*	**1.5 ***	***3.9***
Right Ear	1.6	*5.9*	20.0	*19.7*	**18.4 ***	***19.3***	2.9	*6.9*	22.3	*19.6*	**19.4 ***	***20.1***
Prosodic												
Left Ear	6.1	*8.4*	14.5	*15.2*	**8.4 ***	***13.2***	5.5	*10.3*	14.8	*16.3*	**9.4 ***	***13.1***
Binaural	3.4	*5.2*	8.7	*8.0*	**5.3 ***	***6.7***	4.8	*5.8*	12.6	*12.5*	**7.4 ***	***10.8***
Right Ear	8.7	*11.2*	11.3	*9.6*	**2.6**	***8.9***	7.1	*9.7*	13.2	*14.9*	**6.1 ***	***15.4***

Note. Interference is measured as [Incongruent-Neutral]

* $p < .05$ (one-tailed)

In summary, the pattern of interference observed in Experiment 4 is very similar to that observed in Experiment 3. Generally, greater interference was observed at the left than at the right ear, especially on the prosodic task. This pattern of results is not consistent with any interpretation of the shielding hypothesis, but is consistent with the callosal-channel account if one assumes a mixed model of dichotic listening performance. Experiments 3 and 4 therefore provide converging evidence in support of the hypothesis that interference between linguistic and prosodic processes arises through interhemispheric communication.

GENERAL DISCUSSION

This series of experiments examined the interference between linguistic and prosodic processes in speech perception. Previous studies have demonstrated that these two dimensions are processed in opposite hemispheres (Bowers et al., 1987; Ley & Bryden, 1982) and Experiment 1 demonstrates that this complementary pattern of specialization maintains for the Stroop-like stimuli employed in this study. Interference therefore reflects interhemispheric integration.

Interference between linguistic and prosodic dimensions is asymmetric, that is, linguistic information interferes with prosodic processing more than prosodic information interferes with linguistic processing. However, modest interference was observed on the linguistic task in Experiment 2, and in several conditions of Experiments 3 and 4. This finding argues against a simple speed-of-processing account of the interference effect, as prosodic identification is 200 - 300 ms slower than linguistic identification. Rather, it suggests that linguistic and prosodic information interact throughout the process of speech perception.

These stimuli therefore meet the criteria outlined in the introduction in that they consist of two dimensions that are processed in opposite hemispheres and they interfere with each other.

Experiments 3 and 4 were designed to compare interference that occurs within a hemisphere to that which occurs across hemispheres. The shielding hypothesis predicts greater interference within than across hemispheres, whereas the callosal channel hypothesis makes the opposite prediction. Results from Experiment 3 were somewhat ambiguous, in that a different pattern of results was observed in the RT and in the error data for subjects who responded with the right hand. Similarly, results from the linguistic task are difficult to interpret, in that facilitation was sometimes observed on incongruent trials, and interference effects were not reliable. The findings from left-hand responders on the prosodic task are consistent with the callosal channel hypothesis if one assumes a mixed model of dichotic listening performance, in that interference was greater at the left ear than at the right ear. Recall from Figure 1 that left-ear presentation produces cross-hemisphere processing, but right-ear presentation produces within-hemisphere processing.

The results from Experiment 4 are somewhat more straightforward, at least for the prosodic task. In both the RT and the error data, interference was greater at the left than at the right ear, a finding that is again consistent with the callosal channel hypothesis, and irreconcilable with the shielding hypothesis. Results from the linguistic task are again difficult to interpret, because the interference effects are not reliable. In Experiment 2, under normal binaural conditions, a small amount of interference was observed on the linguistic task. In order to detect differences between ears under dichotic conditions one would have to greatly increase the power of the experiment, either by using more subjects or more trials, or by increasing the amount of prosodic interference through probability manipulations or alteration of the stimuli.

Bilateral Processing Systems

Robertson's theory was developed to explain the integration of global and local analyses in visual processing. She has proposed that there is a bilateral visual processing network in which the left hemisphere component is biased toward local processing and the right hemisphere component is biased toward global processing (Robertson, 1995). The two components of the network are connected by a dedicated callosal communication channel that provides foroptimal integration of global and local analyses.

The speech processing system bears some resemblance to the visual system as it relates to global and local processing. First, speech perception may be an analogous system, in that the two components of speech processing are lateralized to opposite hemispheres. A specialized interhemispheric communication channel would therefore provide optimal integration of linguistic and prosodic information.

Secondly, the relationship may be more concrete, in that both global/local interference and linguistic/prosodic interference may be manifestations of a common mechanism. It has been argued that the global/local dichotomy is a reflection of the hemispheres' differential sensitivities to spatial frequency information (e.g., Hellige, 1995). Specifically, the left hemisphere is specialized for the processing of relatively high spatial frequencies, whereas the right hemisphere is specialized for the processing of relatively low spatial frequencies (Christman, Kitterle, & Hellige, 1991; Sergent, 1992). It has recently been reported that there are hemispheric differences in the processing of auditory stimuli on the basis of temporal frequency that parallel those for visual stimuli (Ivry & Lebby, 1993). It has therefore been argued that the left hemisphere is tuned to high frequency information (spatial or temporal) and the right hemisphere is tuned to low frequency information (Hellige, 1995). Note that phonological information is carried in the high temporal frequencies, and prosodic information is carried in the low temporal frequencies. Linguistic and prosodic components of speech may be auditory analogues of local and global components in visual processing.

Consistent with this hypothesis is the finding that global interference is dissociable from global and local processing in patients. Damage to several cortical areas can result in the impairment of global or local judgments. However, it is only damage to the temporo-parietal junction (T-P) in either hemisphere that disrupts global interference. Global interference may therefore reflect the more general phenomenon of integration of high and low frequency information. This argument is further supported by the fact that the T-P junction is a multi-modal association area, rich in connections to all sensory systems (Robertson, 1995). It would be interesting to determine if patients with damage in this area (or split-brain patients) demonstrate reduced interference between linguistic and prosodic processes, as well as reduced global interference.

The findings of this series of experiments seem very counterintuitive. Robertson's hypothesis provides a theoretical framework that can explain the pattern of results. An alternative explanation can be found in Semmes (1968) hypothesis that localization in the left hemisphere is highly modular, but representation in the right hemisphere is diffuse. If one assumed only direct assess, one would expect greater interference between two dimensions in the diffuse right hemisphere (left ear) than in the modular left hemisphere (right ear). However, this hypothesis does not hold for Stroop stimuli, as Stroop interference is greater in the modularized left hemisphere than in the diffuse right hemisphere (Hugdahl & Franzon, 1985; Schmitt & Davis, 1974).

However, linguistic/prosodic interference is unlike Stroop interference in many ways. I suggest that this is because it reflects the operation of an efficient, bilateral, processing mechanism, designed for the integration of both dimensions. One would hardly expect the development of a bilateral system for the integration of word and colour information.

Whereas the present series of experiments examined linguistic/prosodic interference in normal subjects using dichotic listening techniques, the callosal channel hypothesis was developed on the basis of findings with patients with unilateral lesions and callosal disconnection. If global interference and linguistic interference are analogous (or even identical) mechanisms, converging evidence should be sought from patient studies of linguistic/prosodic integration, and experimental studies of global interference in normals.

Appendix A

Experiment 1: Individual Subject Data

Experiment 1: Linguistic Task

			Linguistic Task					
			Left Ear		Right Ear		Absent	
i.d.	Sex	Target	RT	% error	RT	% error	RT	% error
1	m	mad	1144	24	882	6	1130	1
2	f	mad	942	0	971	0	1071	1
3	m	mad	1179	18	1049	36	1231	9
4	m	sad	838	5	696	6	1045	3
5	m	sad	1044	0	1000	3	1058	0
6	m	sad	780	8	629	0	861	0
7	m	glad	1104	9	966	3	1416	42
8	m	glad	931	6	965	3	981	0
9	m	glad	980	6	888	0	1123	3
10	m	fad	1900	68	926	14	1079	0
11	m	fad	746	35	775	41	680	34

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Linguistic Task

i.d.	Sex	Target	Left Ear		Right Ear		Absent	
			RT	% error	RT	% error	RT	% error
12	m	fad	765	38	783	35	683	36
13	f	mad	1026	12	818	14	1201	0
14	f	mad	1003	0	1014	0	1152	1
15	f	mad	887	18	826	3	1016	1
16	f	sad	724	11	564	3	763	4
17	f	sad	1131	11	963	6	1090	0
18	f	sad	909	3	911	6	1170	1
19	f	glad	869	20	747	9	915	5
20	f	glad	829	3	802	6	870	0
21	f	glad	630	20	487	11	697	12
22	f	fad	885	28	835	16	738	0
23	f	fad	985	11	942	16	1077	11

Continued on next page

Linguistic Task

			Left Ear		Right Ear		Absent	
i.d.	Sex	Target	RT	% error	RT	% error	RT	% error
24	f	fad	848	92	571	2	883	2
25	f	mad	988	29	824	17	1022	5
26	f	sad	1055	0	954	0	1179	0
27	f	glad	886	0	911	9	1094	0
28	f	fad	986	5	830	3	1143	0
29	m	mad	995	15	910	8	1503	0
30	m	sad	732	0	663	6	809	1
31	m	glad	792	31	712	6	965	4
32	m	fad	1081	57	1179	30	1284	3
Means			956	18.1	844	9.8	1029	5.7

Continued on next page

Experiment 1: Prosodic Task

Prosodic Task

i.d.	Sex	Target	Left Ear RT	Left Ear % error	Right Ear RT	Right Ear % error	Absent RT	Absent % error
1	m	sad	1711	44	1389	45	1483	3
2	f	glad	1015	0	1009	0	1061	0
3	m	neutral	1235	28	1232	25	1326	51
4	m	mad	891	38	849	38	988	0
5	m	glad	933	3	949	3	1024	0
6	m	neutral	1109	42	1150	34	1091	46
7	m	mad	1554	38	1718	59	2082	8
8	m	sad	1250	32	1056	21	1147	1
9	m	neutral	2376	33	1879	13	2482	43
10	m	mad	1414	62	2672	76	984	3
11	m	sad	1488	29	1407	39	1355	33

Continued on next page

Prosodic Task

i.d.	Sex	Target	Left Ear		Right Ear		Absent	
			RT	% error	RT	% error	RT	% error
12	m	glad	1225	41	1211	43	1180	47
13	f	sad	875	9	1412	26	1218	1
14	f	glad	879	3	959	0	1118	1
15	f	neutral	1786	17	1772	19	1949	33
16	f	mad	794	22	878	24	1019	1
17	f	glad	1064	0	939	0	1026	0
18	f	neutral	1554	19	1762	78	1618	24
19	f	mad	914	68	1020	59	798	0
20	f	sad	1042	15	1102	32	1148	24
21	f	neutral	874	36	877	53	809	29
22	f	mad	1054	30	1093	35	1195	0
23	f	sad	1125	18	1219	37	1071	1

Continued on next page

Prosodic Task

i.d.	Sex	Target	Left Ear RT	Left Ear % error	Right Ear RT	Right Ear % error	Absent RT	Absent % error
24	f	glad	697	3	693	0	897	7
25	f	mad	844	27	849	38	927	7
26	f	sad	1379	18	1157	8	1563	29
27	f	glad	782	3	808	0	885	0
28	f	neutral	1665	19	1325	28	1754	17
29	m	mad	1070	16	1751	68	1222	3
30	m	sad	940	3	1053	8	1047	0
31	m	glad	774	22	678	5	926	1
32	m	neutral	1175	28	1288	44	1480	18
Means			1172	23.9	1224	29.9	1246	13.6

Appendix B

Experiment 2: Individual Subject Data

Experiment 2: Linguistic Task

Linguistic Task

i.d	Sex	Congruent RT	Congruent % error	Facilitation RT	Facilitation % error	Neutral RT	Neutral % error	Interference RT	Interference % error	Incongruent RT	Incongruent % error
1	f	700	0	-31	-8	731	8	97	0	828	8
2	f	1009	12	-101	8	1110	4	143	22	1253	26
3	f	888	4	122	4	766	0	153	4	919	4
4	f	717	4	-25	-4	742	8	60	-8	802	0
5	f	641	0	51	-4	590	4	10	-4	600	0
6	m	607	0	-16	0	623	0	-18	4	605	4
7	m	714	0	-32	0	746	0	-18	4	728	4
8	m	614	0	-8	0	622	0	119	0	741	0
9	f	724	0	-39	-4	763	4	-15	-4	748	0
10	f	602	0	-29	0	631	0	0	4	631	4
11	f	974	0	176	0	798	0	164	0	962	0

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Linguistic Task

i.d	Sex	Congruent RT	Congruent % error	Facilitation RT	Facilitation % error	Neutral RT	Neutral % error	Interference RT	Interference % error	Incongruent RT	Incongruent % error
12	f	1064	0	-51	0	1115	0	-13	0	1102	0
13	m	1148	0	31	-6	1117	6	0	7	1117	13
14	m	874	0	73	0	801	0	116	0	917	0
15	m	1279	0	100	-4	1179	4	-170	0	1009	4
16	m	606	0	-34	0	640	0	-20	0	620	0
17	m	458	0	-44	0	502	0	-8	4	494	4
18	f	580	8	-27	8	607	0	98	0	705	0
19	m	547	8	0	8	547	0	34	0	581	0
20	m	675	0	-83	-12	758	12	-85	-12	673	0
21	m	620	0	21	-4	599	4	26	0	625	4
22	m	749	4	-38	0	787	4	88	-4	875	0

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Linguistic Task

		Congruent		Facilitation		Neutral		Interference		Incongruent	
i.d	Sex	RT	% error	RT	% error	RT	% error	RT	% error	RT	% error
23	f	713	0	28	0	685	0	-5	0	680	0
24	f	845	0	-2	-4	847	4	12	8	859	12
Means		765	1.7	2	-0.9	763	2.6	32	1	795	3.6

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Experiment 2: Prosodic Task

<u>Prosodic Task</u>

i.d	Sex	Congruent RT	Congruent % error	Facilitation RT	Facilitation % error	Neutral RT	Neutral % error	Interference RT	Interference % error	Incongruent RT	Incongruent % error
1	f	735	0	-21	-4	756	4	124	0	880	4
2	f	1447	0	319	-12	1128	12	558	17	1686	29
3	f	1439	0	-24	0	1463	0	160	12	1623	12
4	f	877	0	0	0	877	0	96	12	973	12
5	f	703	0	-200	0	903	0	-21	8	882	8
6	m	776	4	-98	-4	874	8	41	4	915	12
7	m	787	0	-14	-4	801	4	82	-4	883	0
8	m	685	0	-67	0	752	0	84	8	836	8
9	f	830	0	97	0	733	0	161	8	894	8
10	f	764	0	-38	-4	802	4	164	-4	966	0
11	f	1076	0	-19	0	1095	0	17	8	1112	8

Continued on next page

<u>Prosodic Task</u>

i.d	Sex	Congruent RT	Congruent % error	Facilitation RT	Facilitation % error	Neutral RT	Neutral % error	Interference RT	Interference % error	Incongruent RT	Incongruent % error
12	f	1101	0	-14	0	1115	0	57	8	1172	8
13	m	931	4	158	0	773	4	123	0	896	4
14	m	923	0	7	0	916	0	123	0	1039	0
15	m	867	2	-270	2	1137	0	-270	14	867	14
16	m	909	0	-41	0	950	0	150	0	1100	0
17	m	697	0	31	-8	666	8	192	-4	858	4
18	f	955	0	-203	-4	1158	4	142	16	1300	20
19	m	739	0	-111	-8	850	8	133	4	983	12
20	m	857	0	-34	-8	891	8	11	4	902	12
21	m	607	4	-38	4	645	0	13	4	658	4
22	m	879	0	-7	0	886	0	219	0	1105	0

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Prosodic Task

		Congruent		Facilitation		Neutral		Interference		Incongruent	
i.d	Sex	RT	% error	RT	% error	RT	% error	RT	% error	RT	% error
23	f	907	0	6	-16	901	16	149	-4	1050	12
24	f	1074	0	64	-4	1010	4	120	0	1130	4
Means		899	0.6	-22	-2.9	920	3.5	110	4.6	1030	8.1

Appendix C

Experiment 3: Individual Subject Data

Experiment 3: Linguistic Dichotic Task

Linguistic Dichotic Task

Left Ear

			Congruent		Facilitation		Neutral		Interference		Incongruent	
i.d.	Sex	Hand	RT	% error	RT	% error	RT	% error	RT	% error	RT	% error
1	m	r	959	0.0	-57	0.0	1016	0.0	-41	0.0	975	0.0
2	m	l	1969	58.0	122	8.0	1847	50.0	208	25.0	2055	75.0
3	m	r	818	0.0	-57	0.0	875	0.0	-147	8.0	728	8.0
4	m	l	1272	0.0	171	0.0	1101	0.0	5	0.0	1106	0.0
5	f	r	833	0.0	-121	0.0	954	0.0	7	0.0	961	0.0
6	f	l	816	0.0	-66	0.0	882	0.0	1	0.0	883	0.0
7	f	r	669	0.0	72	-8.0	597	8.0	36	-8.0	633	0.0
8	f	l	763	0.0	0	0.0	763	0.0	-68	16.0	695	16.0
9	m	r	608	0.0	3	-8.0	605	8.0	63	-8.0	668	0.0

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Linguistic Dichotic Task

Left Ear

i.d.	Sex	Hand	Congruent RT	Congruent % error	Facilitation RT	Facilitation % error	Neutral RT	Neutral % error	Interference RT	Interference % error	Incongruent RT	Incongruent % error
10	m	l	844	0.0	-125	0.0	969	0.0	2	16.0	971	16.0
11	m	r	827	8.0	-143	8.0	970	0.0	-205	0.0	765	0.0
12	m	l	918	8.0	-11	8.0	929	0.0	2	0.0	931	0.0
13	f	r	895	0.0	-64	0.0	959	0.0	14	0.0	973	0.0
14	f	l	936	0.0	21	-8.0	915	8.0	155	-8.0	1070	0.0
15	f	r	785	8.0	-181	8.0	966	0.0	-83	8.0	883	8.0
16	f	l	890	0.0	-42	0.0	932	0.0	34	8.0	966	8.0
17	m	r	698	0.0	-11	-8.0	709	8.0	60	0.0	769	8.0
18	m	l	722	0.0	-54	0.0	776	0.0	-72	16.0	704	16.0
19	m	r	830	0.0	-13	0.0	843	0.0	-115	16.0	728	16.0

Continued on next page

Linguistic Dichotic Task

Left Ear

			Congruent		Facilitation		Neutral		Interference		Incongruent	
i.d.	Sex	Hand	RT	% error	RT	% error	RT	% error	RT	% error	RT	% error
20	m	l	938	0.0	104	0.0	834	0.0	67	0.0	901	0.0
21	f	r	841	16.0	120	16.0	721	0.0	201	8.0	922	8.0
22	f	l	741	0.0	-32	0.0	773	0.0	13	8.0	786	8.0
23	f	r	783	0.0	43	0.0	740	0.0	162	0.0	902	0.0
24	f	l	663	8.0	48	0.0	615	8.0	57	-8.0	672	0.0
25	m	r	700	0.0	-12	0.0	712	0.0	36	0.0	748	0.0
26	m	l	699	0.0	-48	0.0	747	0.0	33	0.0	780	0.0
27	m	r	646	16.0	-95	0.0	741	16.0	-118	0.0	623	16.0
28	m	l	768	0.0	-76	0.0	844	0.0	-21	0.0	823	0.0
29	f	r	816	0.0	-25	0.0	841	0.0	-7	0.0	834	0.0

Continued on next page

Linguistic Dichotic Task

Left Ear

			Congruent		Facilitation		Neutral		Interference		Incongruent	
i.d.	Sex	Hand	RT	% error	RT	% error	RT	% error	RT	% error	RT	% error
30	f	l	731	0.0	-44	0.0	775	0.0	51	0.0	826	0.0
31	f	r	823	0.0	40	0.0	783	0.0	50	16.0	833	16.0
32	f	l	677	8.0	16	8.0	661	0.0	28	8.0	689	8.0
Means			840	4.1	-16	0.8	856	3.3	13	3.8	869	7.1

Continued on next page

Linguistic Dichotic Task

Right Ear

i.d.	Sex	Hand	Congruent RT	Congruent % error	Facilitation RT	Facilitation % error	Neutral RT	Neutral % error	Interference RT	Interference % error	Incongruent RT	Incongruent % error
1	m	r	820	0.0	-524	0.0	1344	0	-308	0	1036	0
2	m	l	847	0.0	-165	0.0	1012	0	-103	0	909	0
3	m	r	836	0.0	2	-8.0	834	8	9	-8	843	0
4	m	l	822	0.0	-14	-8.0	836	8	-53	-8	783	0
5	f	r	746	8.0	-177	8.0	923	0	-84	0	839	0
6	f	l	987	0.0	-153	0.0	1140	0	-97	16	1043	16
7	f	r	727	0.0	-107	0.0	834	0	-45	8	789	8
8	f	l	760	8.0	35	8.0	725	0	47	0	772	0
9	m	r	538	0.0	-104	-8.0	642	8	-34	-8	608	0

Continued on next page

Linguistic Dichotic Task

Right Ear

i.d.	Sex	Hand	Congruent RT	Congruent % error	Facilitation RT	Facilitation % error	Neutral RT	Neutral % error	Interference RT	Interference % error	Incongruent RT	Incongruent % error
10	m	l	849	8.0	61	8.0	788	0	-22	0	766	0
11	m	r	795	0.0	-11	-16.0	806	16	42	-8	848	8
12	m	l	827	0.0	93	-8.0	734	8	84	0	818	8
13	f	r	846	16.0	-213	16.0	1059	0	-13	0	1046	0
14	f	l	722	0.0	-192	0.0	914	0	37	0	951	0
15	f	r	793	0.0	56	-8.0	737	8	28	-8	765	0
16	f	l	919	8.0	17	8.0	902	0	156	0	1058	0
17	m	r	730	8.0	-28	8.0	758	0	-86	8	672	8
18	m	l	575	0.0	-37	0.0	612	0	-47	0	565	0
19	m	r	919	0.0	71	0.0	848	0	-80	0	768	0

Continued on next page

Linguistic Dichotic Task

Right Ear

i.d.	Sex	Hand	Congruent RT	Congruent % error	Facilitation RT	Facilitation % error	Neutral RT	Neutral % error	Interference RT	Interference % error	Incongruent RT	Incongruent % error
20	m	l	912	0.0	-65	0.0	977	0	-136	0	841	0
21	f	r	561	0.0	-261	0.0	822	0	-149	16	673	16
22	f	l	672	0.0	-125	0.0	797	0	9	8	806	8
23	f	r	873	0.0	24	0.0	849	0	-4	8	845	8
24	f	l	679	0.0	92	0.0	587	0	96	8	683	8
25	m	r	774	0.0	33	0.0	741	0	-5	8	736	8
26	m	l	719	8.0	-106	8.0	825	0	-20	0	805	0
27	m	r	589	0.0	5	-8.0	584	8	-1	-8	583	0
28	m	l	733	0.0	-47	0.0	780	0	68	0	848	0
29	f	r	865	0.0	60	0.0	805	0	-38	0	767	0

Continued on next page

Linguistic Dichotic Task

Right Ear

i.d.	Sex	Hand	Congruent RT	Congruent % error	Facilitation RT	Facilitation % error	Neutral RT	Neutral % error	Interference RT	Interference % error	Incongruent RT	Incongruent % error
30	f	l	672	0.0	47	0.0	625	0	136	0	761	0
31	f	r	880	0.0	-74	0.0	954	0	-193	0	761	0
32	f	l	691	8.0	-59	0.0	750	8	-53	0	697	8
Means			771	2.3	-58	0.0	830	2.3	-27	1.0	803	3.3

Continued on next page

Experiment 3: Linguistic Binaural Task

Linguistic Binaural Task

Left Ear

			Congruent		Facilitation		Neutral		Interference		Incongruent	
i.d.	Sex	Hand	RT	% error	RT	% error	RT	% error	RT	% error	RT	% error
1	m	r	1029	0.0	21	0.0	1008	0.0	-6	0.0	1002	0.0
2	m	l	1032	0.0	133	0.0	899	0.0	74	0.0	973	0.0
3	m	r	758	0.0	6	0.0	752	0.0	25	0.0	777	0.0
4	m	l	851	8.0	-90	8.0	941	0.0	-29	8.0	912	8.0
5	f	r	862	0.0	-11	0.0	873	0.0	-8	0.0	865	0.0
6	f	l	808	0.0	24	0.0	784	0.0	-26	0.0	758	0.0
7	f	r	770	0.0	-5	0.0	775	0.0	-85	8.0	690	8.0
8	f	l	737	0.0	49	0.0	688	0.0	-43	0.0	645	0.0
9	m	r	550	0.0	-5	0.0	555	0.0	-14	0.0	541	0.0

Continued on next page

Linguistic Binaural Task

Left Ear

			Congruent		Facilitation		Neutral		Interference		Incongruent	
i.d.	Sex	Hand	RT	% error	RT	% error	RT	% error	RT	% error	RT	% error
10	m	l	967	0.0	70	0.0	897	0.0	58	0.0	955	0.0
11	m	r	795	0.0	-9	-8.0	804	8.0	3	0.0	807	8.0
12	m	l	987	8.0	104	8.0	883	0.0	359	8.0	1242	8.0
13	f	r	931	0.0	-22	-8.0	953	8.0	45	-8.0	998	0.0
14	f	l	899	8.0	117	8.0	782	0.0	27	8.0	809	8.0
15	f	r	836	0.0	81	0.0	755	0.0	92	0.0	847	0.0
16	f	l	912	0.0	43	-8.0	869	8.0	87	-8.0	956	0.0
17	m	r	687	0.0	26	0.0	661	0.0	73	0.0	734	0.0
18	m	l	621	0.0	-51	0.0	672	0.0	0	8.0	672	8.0
19	m	r	794	16.0	50	16.0	744	0.0	68	8.0	812	8.0

Continued on next page

Linguistic Binaural Task

Left Ear

i.d.	Sex	Hand	Congruent RT	Congruent % error	Facilitation RT	Facilitation % error	Neutral RT	Neutral % error	Interference RT	Interference % error	Incongruent RT	Incongruent % error
20	m	l	851	0.0	-42	0.0	893	0.0	12	0.0	905	0.0
21	f	r	691	0.0	44	0.0	647	0.0	164	0.0	811	0.0
22	f	l	650	0.0	-36	-8.0	686	8.0	20	-8.0	706	0.0
23	f	r	873	0.0	76	0.0	797	0.0	8	0.0	805	0.0
24	f	l	648	0.0	105	0.0	543	0.0	80	0.0	623	0.0
25	m	r	672	0.0	-15	-8.0	687	8.0	12	-8.0	699	0.0
26	m	l	714	0.0	8	0.0	706	0.0	-27	0.0	679	0.0
27	m	r	675	0.0	30	0.0	645	0.0	23	0.0	668	0.0
28	m	l	818	0.0	19	0.0	799	0.0	76	0.0	875	0.0
29	f	r	723	0.0	-32	0.0	755	0.0	-3	0.0	752	0.0

Continued on next page

Linguistic Binaural Task

Left Ear

			Congruent		Facilitation		Neutral		Interference		Incongruent	
i.d.	Sex	Hand	RT	% error	RT	% error	RT	% error	RT	% error	RT	% error
30	f	l	734	0.0	-10	0.0	744	0.0	86	0.0	830	0.0
31	f	r	723	0.0	36	0.0	687	0.0	114	0.0	801	0.0
32	f	l	637	0.0	-69	-8.0	706	8.0	-71	0.0	635	8.0
Means			789	1.3	20	-0.3	768	1.5	37	0.5	806	2.0

Continued on next page

Linguistic Binaural Task

Right Ear

			Congruent		Facilitation		Neutral		Interference		Incongruent	
i.d.	Sex	Hand	RT	% error	RT	% error	RT	% error	RT	% error	RT	% error
1	m	r	991	0.0	-249	0.0	1240	0	-213	0	1027	0
2	m	l	839	0.0	-33	-8.0	872	8	180	-8	1052	0
3	m	r	742	0.0	-51	-8.0	793	8	19	-8	812	0
4	m	l	702	0.0	-9	0.0	711	0	68	0	779	0
5	f	r	955	0.0	161	0.0	794	0	39	0	833	0
6	f	l	1041	0.0	165	0.0	876	0	31	0	907	0
7	f	r	755	0.0	54	0.0	701	0	67	8	768	8
8	f	l	678	8.0	-87	8.0	765	0	-65	0	700	0
9	m	r	577	0.0	57	0.0	520	0	85	0	605	0

Continued on next page

Linguistic Binaural Task

Right Ear

			Congruent		Facilitation		Neutral		Interference		Incongruent	
i.d.	Sex	Hand	RT	% error	RT	% error	RT	% error	RT	% error	RT	% error
10	m	l	816	0.0	47	0.0	769	0	110	0	879	0
11	m	r	811	0.0	30	0.0	781	0	67	0	848	0
12	f	l	740	0.0	22	0.0	718	0	323	8	1041	8
13	f	r	818	0.0	-175	0.0	993	0	-103	0	890	0
14	f	l	887	0.0	-32	0.0	919	0	29	0	948	0
15	f	r	620	0.0	-103	-16.0	723	16	6	-16	729	0
16	f	l	866	0.0	11	0.0	855	0	50	0	905	0
17	m	r	600	0.0	28	0.0	572	0	173	0	745	0
18	m	l	597	0.0	6	0.0	591	0	135	0	726	0
19	m	r	679	0.0	-54	0.0	733	0	7	0	740	0

Continued on next page

Linguistic Binaural Task

Right Ear

			Congruent		Facilitation		Neutral		Interference		Incongruent	
i.d.	Sex	Hand	RT	% error	RT	% error	RT	% error	RT	% error	RT	% error
20	m	l	829	0.0	18	0.0	811	0	65	0	876	0
21	f	r	594	0.0	-31	0.0	625	0	69	0	694	0
22	f	l	683	0.0	-7	0.0	690	0	-11	0	679	0
23	f	r	841	0.0	-78	-8.0	919	8	62	-8	981	0
24	f	l	613	0.0	27	0.0	586	0	89	0	675	0
25	m	r	712	0.0	1	0.0	711	0	-3	0	708	0
26	m	l	766	0.0	-39	0.0	805	0	3	0	808	0
27	m	r	536	8.0	56	8.0	480	0	13	0	493	0
28	m	l	706	0.0	-6	0.0	712	0	-17	0	695	0
29	f	r	690	0.0	-94	0.0	784	0	-69	0	715	0

Continued on next page

Linguistic Binaural Task

Right Ear

i.d.	Sex	Hand	Congruent RT	Congruent % error	Facilitation RT	Facilitation % error	Neutral RT	Neutral % error	Interference RT	Interference % error	Incongruent RT	Incongruent % error
30	f	l	719	0.0	1	0.0	718	0	-63	0	655	0
31	f	r	726	0.0	6	0.0	720	0	35	0	755	0
32	f	l	661	0.0	-23	0.0	684	0	-34	8	650	8
Means			743	0.5	-12	-0.8	755	1.25	36	-0.5	791	0.75

Experiment 3: Prosodic Dichotic Task

<u>Prosodic Dichotic Task</u>

Left Ear

			Congruent		Facilitation		Neutral		Interference		Incongruent	
i.d.	Sex	Hand	RT	% error	RT	% error	RT	% error	RT	% error	RT	% error
1	m	r	1686	8	-111	0.0	1797	8	-311	8.0	1486	16
2	m	l	1370	16	-407	8.0	1777	8	-163	8.0	1614	16
3	m	r	724	0	-10	0.0	734	0	78	8.0	812	8
4	m	l	1204	0	-149	0.0	1353	0	582	41.0	1935	41
5	f	r	1090	0	-79	0.0	1169	0	12	0.0	1181	0
6	f	l	958	0	-54	0.0	1012	0	19	16.0	1031	16
7	f	r	690	0	-85	-8.0	775	8	208	0.0	983	8
8	f	l	1111	0	8	-8.0	1103	8	119	0.0	1222	8
9	m	r	787	0	20	0.0	767	0	216	16.0	983	16

Continued on next page

Prosodic Dichotic Task

Left Ear

i.d.	Sex	Hand	Congruent RT	Congruent % error	Facilitation RT	Facilitation % error	Neutral RT	Neutral % error	Interference RT	Interference % error	Incongruent RT	Incongruent % error
10	m	l	1060	8	-344	0.0	1404	8	-151	0.0	1253	8
11	m	r	893	8	-37	8.0	930	0	156	25.0	1086	25
12	m	l	765	8	87	8.0	678	0	281	25.0	959	25
13	f	r	1209	0	167	0.0	1042	0	347	8.0	1389	8
14	f	l	1080	0	204	0.0	876	0	216	8.0	1092	8
15	f	r	1034	0	-359	-16.0	1393	16	-251	-8.0	1142	8
16	f	l	1084	0	-24	-8.0	1108	8	8	17.0	1116	25
17	m	r	772	8	57	8.0	715	0	66	8.0	781	8
18	m	l	1018	8	-209	8.0	1227	0	-52	16.0	1175	16
19	m	r	1870	0	142	-8.0	1728	8	-110	-8.0	1618	0

Continued on next page

Prosodic Dichotic Task

Left Ear

i.d.	Sex	Hand	Congruent RT	Congruent % error	Facilitation RT	Facilitation % error	Neutral RT	Neutral % error	Interference RT	Interference % error	Incongruent RT	Incongruent % error
20	m	l	1016	0	-119	-8.0	1135	8	20	8.0	1155	16
21	f	r	850	0	-158	-16.0	1008	16	-11	-8.0	997	8
22	f	l	858	0	-31	-8.0	889	8	124	0.0	1013	8
23	f	r	1025	8	-200	0.0	1225	8	-3	-8.0	1222	0
24	f	l	686	8	-77	8.0	763	0	22	16.0	785	16
25	m	r	841	0	-57	0.0	898	0	-79	8.0	819	8
26	m	l	1038	8	-1	8.0	1039	0	116	25.0	1155	25
27	m	r	768	8	-57	8.0	825	0	-29	16.0	796	16
28	m	l	841	0	63	-8.0	778	8	163	-8.0	941	0
29	f	r	1012	0	-4	-8.0	1016	8	74	-8.0	1090	0

Continued on next page

Prosodic Dichotic Task

Left Ear

			Congruent		Facilitation		Neutral		Interference		Incongruent	
i.d.	Sex	Hand	RT	% error	RT	% error	RT	% error	RT	% error	RT	% error
30	f	l	958	0	-174	0.0	1132	0	37	16.0	1169	16
31	f	r	1234	0	-50	-16.0	1284	16	-209	-8.0	1075	8
32	f	l	871	8	-164	0.0	1035	8	183	8.0	1218	16
Means			1013	3.3	-69	-1.5	1082	4.8	52	7.7	1134	12.4

Continued on next page

<u>Prosodic Dichotic Task</u>

Right Ear

			Congruent		Facilitation		Neutral		Interference		Incongruent	
i.d.	Sex	Hand	RT	% error	RT	% error	RT	% error	RT	% error	RT	% error
1	m	r	1637	8	-85	8.0	1722	0	-98	0	1624	0
2	m	l	1168	25	-461	9.0	1629	16	-311	0	1318	16
3	m	r	746	8	-141	8.0	887	0	-52	25	835	25
4	m	l	1202	0	-29	-8.0	1231	8	-105	25	1126	33
5	f	r	1058	0	-111	0.0	1169	0	53	8	1222	8
6	f	l	1027	8	-181	8.0	1208	0	46	0	1254	0
7	f	r	787	0	-69	0.0	856	0	44	25	900	25
8	f	l	950	0	-379	0.0	1329	0	-148	33	1181	33
9	m	r	704	0	22	0.0	682	0	208	16	890	16

Continued on next page

Prosodic Dichotic Task

Right Ear

i.d.	Sex	Hand	Congruent RT	Congruent % error	Facilitation RT	Facilitation % error	Neutral RT	Neutral % error	Interference RT	Interference % error	Incongruent RT	Incongruent % error
10	m	l	1309	0	168	0.0	1141	0	312	16	1453	16
11	m	r	890	0	-31	-8.0	921	8	160	25	1081	33
12	m	l	840	0	1	-33.0	839	33	121	-17	960	16
13	f	r	983	0	-54	0.0	1037	0	99	8	1136	8
14	f	l	987	0	-248	0.0	1235	0	-260	8	975	8
15	f	r	1107	0	-167	0.0	1274	0	14	25	1288	25
16	f	l	968	0	-45	-8.0	1013	8	261	0	1274	8
17	m	r	836	8	-91	8.0	927	0	-122	0	805	0
18	m	l	1213	8	-246	-8.0	1459	16	-270	-8	1189	8
19	m	r	1887	0	260	0.0	1627	0	-170	25	1457	25

Continued on next page

Prosodic Dichotic Task

Right Ear

i.d.	Sex	Hand	Congruent RT	Congruent % error	Facilitation RT	Facilitation % error	Neutral RT	Neutral % error	Interference RT	Interference % error	Incongruent RT	Incongruent % error
20	m	l	973	0	61	0.0	912	0	-71	0	841	0
21	f	r	817	0	-34	0.0	851	0	-178	16	673	16
22	f	l	790	0	-150	0.0	940	0	-134	8	806	8
23	f	r	1163	0	-199	0.0	1362	0	-517	8	845	8
24	f	l	775	0	-138	0.0	913	0	-230	8	683	8
25	m	r	774	0	-58	0.0	832	0	-96	8	736	8
26	m	l	926	0	-70	0.0	996	0	-191	0	805	0
27	m	r	657	0	-86	0.0	743	0	-160	0	583	0
28	m	l	779	0	25	0.0	754	0	94	0	848	0
29	f	r	866	0	-182	0.0	1048	0	-281	0	767	0

Continued on next page

Prosodic Dichotic Task

Right Ear

i.d.	Sex	Hand	Congruent RT	Congruent % error	Facilitation RT	Facilitation % error	Neutral RT	Neutral % error	Interference RT	Interference % error	Incongruent RT	Incongruent % error
30	f	l	1049	0	13	0.0	1036	0	-102	0	934	0
31	f	r	975	0	-126	0.0	1101	0	-200	16	901	16
32	f	l	1012	0	-157	-8.0	1169	8	188	17	1357	25
Means			995	2.0	-93	-1.0	1089	3.0	-66	9.2	1023	12.3

Continued on next page

Experiment 3: Prosodic Binaural Task

<u>Prosodic Binaural Task</u>

Left Ear

i.d.	Sex	Hand	Congruent RT	Congruent % error	Facilitation RT	Facilitation % error	Neutral RT	Neutral % error	Interference RT	Interference % error	Incongruent RT	Incongruent % error
1	m	r	1583	0	182	0.0	1401	0	-65	8.0	1336	8
2	m	l	1550	8	-121	0.0	1671	8	-337	0.0	1334	8
3	m	r	721	0	-27	0.0	748	0	90	0.0	838	0
4	m	l	1458	0	48	-8.0	1410	8	-206	0.0	1204	8
5	f	r	1209	0	-189	0.0	1398	0	65	0.0	1463	0
6	f	l	1090	0	183	-8.0	907	8	122	-8.0	1029	0
7	f	r	836	0	-29	0.0	865	0	186	8.0	1051	8
8	f	l	868	0	-87	0.0	955	0	508	8.0	1463	8
9	m	r	866	0	169	0.0	697	0	334	8.0	1031	8

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Prosodic Binaural Task

Left Ear

i.d.	Sex	Hand	Congruent RT	Congruent % error	Facilitation RT	Facilitation % error	Neutral RT	Neutral % error	Interference RT	Interference % error	Incongruent RT	Incongruent % error
10	m	l	1172	0	-559	-16.0	1731	16	-443	-8.0	1288	8
11	m	r	778	16	-138	8.0	916	8	-6	0.0	910	8
12	m	l	781	0	18	0.0	763	0	73	8.0	836	8
13	f	r	1184	0	13	-8.0	1171	8	33	0.0	1204	8
14	f	l	913	0	-127	0.0	1040	0	18	33.0	1058	33
15	f	r	938	0	-252	0.0	1190	0	-67	0.0	1123	0
16	f	l	936	0	-48	0.0	984	0	70	0.0	1054	0
17	m	r	687	0	-22	0.0	709	0	30	0.0	739	0
18	m	l	1090	0	13	0.0	1077	0	373	16.0	1450	16
19	m	r	1492	0	427	0.0	1065	0	813	8.0	1878	8

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Prosodic Binaural Task

Left Ear

i.d.	Sex	Hand	Congruent RT	Congruent % error	Facilitation RT	Facilitation % error	Neutral RT	Neutral % error	Interference RT	Interference % error	Incongruent RT	Incongruent % error
20	m	l	809	0	-329	-8.0	1138	8	-237	-8.0	901	0
21	f	r	1071	8	150	-8.0	921	16	152	-16.0	1073	0
22	f	l	872	0	-4	0.0	876	0	83	8.0	959	8
23	f	r	970	0	-128	0.0	1098	0	97	0.0	1195	0
24	f	l	701	0	-112	-16.0	813	16	2	-16.0	815	0
25	m	r	961	0	173	0.0	788	0	93	25.0	881	25
26	m	l	1040	0	-41	-8.0	1081	8	-15	8.0	1066	16
27	m	r	748	0	47	0.0	701	0	179	8.0	880	8
28	m	l	734	0	53	0.0	681	0	196	8.0	877	8
29	f	r	877	8	-123	8.0	1000	0	105	0.0	1105	0

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Prosodic Binaural Task

Left Ear

i.d.	Sex	Hand	Congruent RT	Congruent % error	Facilitation RT	Facilitation % error	Neutral RT	Neutral % error	Interference RT	Interference % error	Incongruent RT	Incongruent % error
30	f	l	991	0	-66	0.0	1057	0	97	8.0	1154	8
31	f	r	801	16	-60	16.0	861	0	137	16.0	998	16
32	f	l	989	0	-21	-8.0	1010	8	70	8.0	1080	16
Means			991	1.8	-31	-1.8	1023	3.5	80	4.1	1102	7.6

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Prosodic Binaural Task

Right Ear

i.d.	Sex	Hand	Congruent RT	Congruent % error	Facilitation RT	Facilitation % error	Neutral RT	Neutral % error	Interference RT	Interference % error	Incongruent RT	Incongruent % error
1	m	r	2027	0	693	0.0	1334	0	57	0	1391	0
2	m	l	998	0	-565	-8.0	1563	8	-187	-8	1376	0
3	m	r	735	0	-38	0.0	773	0	8	33	781	33
4	m	l	1241	0	-401	-8.0	1642	8	-211	0	1431	8
5	f	r	981	0	-56	0.0	1037	0	153	0	1190	0
6	f	l	968	0	7	0.0	961	0	143	0	1104	0
7	f	r	751	0	-36	0.0	787	0	-37	25	750	25
8	f	l	893	0	-6	-8.0	899	8	154	0	1053	8
9	m	r	774	0	-42	-8.0	816	8	75	0	891	8

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Prosodic Binaural Task

Right Ear

i.d.	Sex	Hand	Congruent		Facilitation		Neutral		Interference		Incongruent	
			RT	% error	RT	% error	RT	% error	RT	% error	RT	% error
10	m	l	1352	0	83	-8.0	1269	8	228	-8	1497	0
11	m	r	1020	0	193	-8.0	827	8	121	0	948	8
12	f	l	733	0	-11	0.0	744	0	118	8	862	8
13	f	r	930	0	-42	-8.0	972	8	27	8	999	16
14	f	l	954	0	77	0.0	877	0	166	16	1043	16
15	f	r	1011	0	-228	-16.0	1239	16	21	-8	1260	8
16	f	l	969	0	-135	0.0	1104	0	-41	8	1063	8
17	m	r	726	0	45	0.0	681	0	42	0	723	0
18	m	l	857	0	-134	0.0	991	0	127	16	1118	16
19	m	r	1354	0	-134	0.0	1488	0	113	0	1601	0

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Prosodic Binaural Task

Right Ear

i.d.	Sex	Hand	Congruent RT	Congruent % error	Facilitation RT	Facilitation % error	Neutral RT	Neutral % error	Interference RT	Interference % error	Incongruent RT	Incongruent % error
20	m	l	937	0	-152	-8.0	1089	8	-13	0	1076	8
21	f	r	762	0	-51	0.0	813	0	100	8	913	8
22	f	l	955	0	-51	-8.0	1006	8	-37	-8	969	0
23	f	r	951	0	-67	0.0	1018	0	108	16	1126	16
24	f	l	755	0	9	-16.0	746	16	320	0	1066	16
25	m	r	752	0	-41	0.0	793	0	38	8	831	8
26	m	l	898	0	79	0.0	819	0	87	16	906	16
27	m	r	672	0	10	0.0	662	0	68	8	730	8
28	m	l	783	0	0	0.0	783	0	137	0	920	0
29	f	r	828	0	22	0.0	806	0	101	8	907	8

Continued on next page

Prosodic Binaural Task

Right Ear

i.d.	Sex	Hand	Congruent RT	Congruent % error	Facilitation RT	Facilitation % error	Neutral RT	Neutral % error	Interference RT	Interference % error	Incongruent RT	Incongruent % error
30	f	l	984	0	-74	0.0	1058	0	16	0	1074	0
31	f	r	754	0	-330	-16.0	1084	16	-166	0	918	16
32	f	l	990	0	-14	-8.0	1004	8	42	17	1046	25
Means			947	0.0	-43	-4.0	990	4	59	5.1	1049	9.1

Appendix D

Experiment 4: Individual Subject Data

Experiment 4

Linguistic Dichotic Task - Left Hand, Left Ear

		Congruent		Facilitation		Neutral		Interference		Incongruent	
i.d.	Sex	RT	% Error	RT	% Error	RT	% Error	RT	% Error	RT	% Error
1	m	885	0	-174	0.0	1059	0	-150	0.0	909	0
2	m	1160	0	-13	0.0	1173	0	-33	0.0	1140	0
3	m	713	0	27	0.0	686	0	2	0.0	688	0
4	m	924	10	-20	10.0	944	0	187	0.0	1131	0
5	f	911	0	30	-20.0	881	20	18	0.0	899	20
6	f	916	0	-44	0.0	960	0	15	0.0	975	0
7	f	755	0	-13	0.0	768	0	-67	0.0	701	0
8	f	1208	20	65	-30.0	1143	50	-60	30.0	1083	80
9	m	631	0	-8	0.0	639	0	162	0.0	801	0
10	m	858	0	52	0.0	806	0	175	0.0	981	0
11	m	616	0	46	0.0	570	0	16	0.0	586	0
12	m	874	0	-66	-10.0	940	10	-17	-10.0	923	0

13	f	850	0	114	0.0	736	0	93	10.0	829	10
14	f	690	0	-51	0.0	741	0	-112	0.0	629	0
15	f	920	0	-285	-10.0	1205	10	-87	0.0	1118	10
16	f	686	0	1	0.0	685	0	83	0.0	768	0
17	m	768	0	117	0.0	651	0	49	10.0	700	10
18	m	671	0	-117	0.0	788	0	-42	10.0	746	10
19	m	1159	0	-210	0.0	1369	0	-343	0.0	1026	0
20	m	810	0	-58	0.0	868	0	-25	20.0	843	20
21	f	1124	0	253	0.0	871	0	-15	0.0	856	0
22	f	746	0	-337	0.0	1083	0	-317	10.0	766	10
23	f	788	0	-108	0.0	896	0	25	0.0	921	0
24	f	673	10	-197	0.0	870	10	44	10.0	914	20
25	m	714	20	23	20.0	691	0	7	0.0	698	0
26	m	549	30	-407	-20.0	956	50	-254	-10.0	702	40
27	m	1033	0	227	0.0	806	0	120	0.0	926	0

28	m	731	10	-47	10.0	778	0	222	0.0	1000	0
29	f	866	0	-328	-10.0	1194	10	-68	-10.0	1126	0
30	f	1687	10	-913	10.0	2600	0	-1099	10.0	1501	10
31	f	759	0	-200	0.0	959	0	-211	0.0	748	0
32	f	1025	0	98	-10.0	927	10	34	-10.0	961	0
Means		866	3	-79	-2	945	5	-52	2	894	8

Linguistic Binaural Task - Left Hand, Left Ear

i.d.	Sex	Congruent RT	Congruent % Error	Facilitation RT	Facilitation % Error	Neutral RT	Neutral % Error	Interference RT	Interference % Error	Incongruent RT	Incongruent % Error
1	m	925	0	73	0.0	852	0	-34	0.0	818	0
2	m	1205	10	-18	10.0	1223	0	-35	10.0	1188	10
3	m	556	0	-170	0.0	726	0	-105	0.0	621	0
4	m	876	0	71	0.0	805	0	36	0.0	841	0
5	f	685	0	20	0.0	665	0	6	0.0	671	0
5	f	768	0	132	0.0	636	0	89	10.0	725	10
7	f	658	0	-67	0.0	725	0	-4	0.0	721	0
8	f	1166	50	116	-40.0	1050	90	137	-30.0	1187	60
9	m	741	0	65	0.0	676	0	5	10.0	681	10
10	m	761	0	-10	0.0	771	0	22	0.0	793	0
11	m	510	0	-93	0.0	603	0	13	0.0	616	0
12	m	831	20	46	20.0	785	0	-37	0.0	748	0

13	f	798	0	63	0.0	735	0	-37	0.0	698	0
14	f	690	0	79	0.0	611	0	72	0.0	683	0
15	f	813	0	-210	0.0	1023	0	-327	0.0	696	0
16	f	656	0	67	-20.0	589	20	72	-20.0	661	0
17	m	603	10	35	10.0	568	0	40	0.0	608	0
18	m	600	0	-41	0.0	641	0	145	10.0	786	10
19	m	936	10	30	10.0	906	0	43	0.0	949	0
20	m	643	0	7	0.0	636	0	-5	20.0	631	20
21	f	870	0	152	0.0	718	0	67	0.0	785	0
22	f	650	0	-87	-10.0	737	10	-136	-10.0	601	0
23	f	859	10	43	10.0	816	0	-71	0.0	745	0
24	f	530	0	-81	0.0	611	0	50	0.0	661	0
25	m	625	0	-54	0.0	679	0	29	0.0	708	0
26	m	708	20	-240	0.0	948	20	-347	-10.0	601	10
27	m	751	0	-45	0.0	796	0	-62	0.0	734	0

28	m	543	0	-87	0.0	630	0	-15	0.0	615	0
29	f	1133	0	165	-10.0	968	10	43	-10.0	1011	0
30	f	1100	30	17	30.0	1083	0	296	10.0	1379	10
31	f	724	0	-192	0.0	916	0	-260	0.0	656	0
32	f	942	10	-229	10.0	1171	0	-283	0.0	888	0
Means		777	5	-14	1	791	5	-19	0	772	4

Linguistic Dichotic Task - Left Hand, Right Ear

i.d.	Sex	Congruent RT	Congruent % Error	Facilitation RT	Facilitation % Error	Neutral RT	Neutral % Error	Interference RT	Interference % Error	Incongruent RT	Incongruent % Error
1	m	1165	0	-131	0.0	1296	0	-156	10.0	1140	10
2	m	1116	0	-235	0.0	1351	0	-196	0.0	1155	0
3	m	728	0	120	0.0	608	0	65	0.0	673	0
4	m	1235	20	187	20.0	1048	0	45	0.0	1093	0
5	f	864	0	-36	0.0	900	0	-59	0.0	841	0
5	f	770	20	81	20.0	689	0	412	10.0	1101	10
7	f	749	0	101	0.0	648	0	93	0.0	741	0
8	f	933	70	-539	0.0	1472	70	-443	-10.0	1029	60
9	m	775	0	75	0.0	700	0	46	40.0	746	40
10	m	738	10	-433	10.0	1171	0	-348	50.0	823	50
11	m	592	10	57	10.0	535	0	-28	30.0	507	30
12	m	676	0	-50	0.0	726	0	61	10.0	787	10

13	f	811	10	31	10.0	780	0	114	40.0	894	40
14	f	666	10	8	10.0	658	0	-42	40.0	616	40
15	f	1119	30	-174	30.0	1293	0	-460	40.0	833	40
16	f	577	10	-26	10.0	603	0	19	40.0	622	40
17	m	705	0	119	0.0	586	0	128	0.0	714	0
18	m	625	0	-41	0.0	666	0	55	0.0	721	0
19	m	1088	0	276	-10.0	812	10	176	0.0	988	10
20	m	620	0	-256	0.0	876	0	-70	0.0	806	0
21	f	1276	0	421	0.0	855	0	273	0.0	1128	0
22	f	716	0	78	0.0	638	0	83	0.0	721	0
23	f	1002	10	97	10.0	905	0	19	0.0	924	0
24	f	746	10	142	10.0	604	0	-38	0.0	566	0
25	m	833	0	-10	0.0	843	0	-2	40.0	841	40
26	m	1476	10	803	-20.0	673	30	107	10.0	780	40
27	m	823	0	17	0.0	806	0	156	20.0	962	20

28	m	705	0	84	0.0	621	0	156	40.0	777	40
29	f	985	0	-151	0.0	1136	0	-109	20.0	1027	20
30	f	1155	10	-444	0.0	1599	10	-416	30.0	1183	40
31	f	698	0	-5	0.0	703	0	230	50.0	933	50
32	f	953	10	-50	10.0	1003	0	246	50.0	1249	50
Means		873	8	4	4	869	4	4	18	873	21

Linguistic Binaural Task - Left Hand, Right Ear

i.d.	Sex	Congruent RT	Congruent % Error	Facilitation RT	Facilitation % Error	Neutral RT	Neutral % Error	Interference RT	Interference % Error	Incongruent RT	Incongruent % Error
1	m	838	0	123	0.0	715	0	10	0.0	725	0
2	m	1018	0	-305	0.0	1323	0	-154	0.0	1169	0
3	m	566	0	1	0.0	565	0	-12	10.0	553	10
4	m	960	0	-34	0.0	994	0	-95	0.0	899	0
5	f	709	0	73	0.0	636	0	177	0.0	813	0
5	f	690	0	-61	0.0	751	0	-63	0.0	688	0
7	f	621	0	-44	0.0	665	0	84	0.0	749	0
8	f	770	60	-238	0.0	1008	60	-92	10.0	916	70
9	m	635	10	-90	10.0	725	0	-44	0.0	681	0
10	m	793	0	-87	0.0	880	0	-144	0.0	736	0
11	m	646	0	71	0.0	575	0	60	0.0	635	0
12	m	741	0	-65	0.0	806	0	-65	0.0	741	0

13	f	728	0	12	0.0	716	0	-157	0.0	559	0
14	f	581	0	-125	0.0	706	0	-138	0.0	568	0
15	f	806	0	125	-10.0	681	10	-25	-10.0	656	0
16	f	608	0	-216	-10.0	824	10	-213	-10.0	611	0
17	m	687	20	-25	10.0	712	10	-46	-10.0	666	0
18	m	695	0	77	0.0	618	0	13	10.0	631	10
19	m	875	0	79	0.0	796	0	232	0.0	1028	0
20	m	637	0	-101	0.0	738	0	20	0.0	758	0
21	f	806	0	5	0.0	801	0	-39	10.0	762	10
22	f	736	0	101	0.0	635	0	94	10.0	729	10
23	f	730	0	-141	0.0	871	0	60	0.0	931	0
24	f	584	0	-86	0.0	670	0	-145	0.0	525	0
25	m	758	0	60	-10.0	698	10	65	-10.0	763	0
26	m	635	10	-77	-10.0	712	20	525	0.0	1237	20
27	m	670	0	-86	0.0	756	0	160	0.0	916	0

28	m	622	10	-1	10.0	623	0	-7	10.0	616	10
29	f	911	10	-269	10.0	1180	0	-152	0.0	1028	0
30	f	983	0	-267	-10.0	1250	10	-44	-10.0	1206	0
31	f	670	0	-85	0.0	755	0	-154	0.0	601	0
32	f	875	0	-86	0.0	961	0	16	20.0	977	20
Means		737	4	-55	0	792	4	-9	1	784	5

Linguistic Dichotic Task - Right Hand, Left Ear

		Congruent		Facilitation		Neutral		Interference		Incongruent	
i.d.	Sex	RT	% Error	RT	% Error	RT	% Error	RT	% Error	RT	% Error
1	m	711	0	-62	0.0	773	0	-37	10.0	736	10
2	m	874	0	-119	0.0	993	0	41	0.0	1034	0
3	m	610	0	-3	0.0	613	0	1	0.0	614	0
4	m	751	0	3	0.0	748	0	15	0.0	763	0
5	f	1003	0	250	0.0	753	0	-45	0.0	708	0
5	f	651	10	-50	10.0	701	0	-18	10.0	683	10
7	f	831	0	111	0.0	720	0	65	0.0	785	0
8	f	820	60	-125	0.0	945	60	-29	-10.0	916	50
9	m	853	0	-152	-10.0	1005	10	-153	10.0	852	20
10	m	861	0	60	-10.0	801	10	49	-10.0	850	0
11	m	659	0	20	0.0	639	0	167	0.0	806	0
12	m	1126	10	-37	10.0	1163	0	-5	0.0	1158	0

13	f	778	0	64	-10.0	714	10	110	-10.0	824	0
14	f	634	0	-102	0.0	736	0	-75	0.0	661	0
15	f	880	0	2	0.0	878	0	88	10.0	966	10
16	f	706	0	-92	-10.0	798	10	28	-10.0	826	0
17	m	636	0	-115	-10.0	751	10	36	10.0	787	20
18	m	761	0	58	0.0	703	0	30	0.0	733	0
19	m	1005	10	29	0.0	976	10	117	10.0	1093	20
20	m	800	10	-38	10.0	838	0	-115	20.0	723	20
21	f	933	0	30	0.0	903	0	10	0.0	913	0
22	f	696	0	-104	0.0	800	0	56	0.0	856	0
23	f	815	0	-268	0.0	1083	0	-255	0.0	828	0
24	f	1020	0	62	0.0	958	0	95	0.0	1053	0
25	m	683	0	-18	0.0	701	0	-48	0.0	653	0
26	m	774	20	97	10.0	677	10	597	10.0	1274	20
27	m	1048	0	92	0.0	956	0	0	0.0	956	0

28	m	891	0	100	0.0	791	0	69	0.0	860	0
29	f	1108	0	-8	0.0	1116	0	-81	0.0	1035	0
30	f	1814	10	-42	10.0	1856	0	-67	10.0	1789	10
31	f	855	0	-154	-10.0	1009	10	-76	-10.0	933	0
32	f	810	0	-106	0.0	916	0	-50	0.0	866	0
Means		856	4	-19	0	875	4	16	2	892	6

13	f	736	0	-54	0.0	790	0	-64	0.0	726	0
14	f	603	10	10	10.0	593	0	5	0.0	598	0
15	f	888	0	-30	0.0	918	0	173	0.0	1091	0
16	f	640	10	-76	10.0	716	0	77	0.0	793	0
17	m	633	10	20	10.0	613	0	70	10.0	683	10
18	m	658	0	-37	0.0	695	0	-85	0.0	610	0
19	m	963	0	99	0.0	864	0	-3	0.0	861	0
20	m	718	0	-66	0.0	784	0	-86	10.0	698	10
21	f	711	0	51	0.0	660	0	23	10.0	683	10
22	f	674	0	-107	0.0	781	0	-69	10.0	712	10
23	f	651	0	48	0.0	603	0	48	0.0	651	0
24	f	796	0	28	0.0	768	0	223	0.0	991	0
25	m	606	0	-37	0.0	643	0	110	0.0	753	0
26	m	760	10	44	-10.0	716	20	1117	0.0	1833	20
27	m	1123	0	418	0.0	705	0	255	0.0	960	0

28	m	708	0	39	0.0	669	0	-124	20.0	545	20
29	f	1128	0	168	0.0	960	0	63	0.0	1023	0
30	f	1093	20	-514	10.0	1607	10	128	0.0	1735	10
31	f	824	10	-189	10.0	1013	0	-190	0.0	823	0
32	f	658	0	-145	-10.0	803	10	33	-10.0	836	0
Means		749	5	-20	1	769	4	65	2	834	6

Linguisitic Dichotic Task - Right Hand, Right Ear

		Congruent		Facilitation		Neutral		Interference		Incongruent	
i.d.	Sex	RT	% Error	RT	% Error	RT	% Error	RT	% Error	RT	% Error
1	m	999	10	156	-10.0	843	20	68	20.0	911	40
2	m	874	10	-156	10.0	1030	0	6	50.0	1036	50
3	m	495	0	-36	0.0	531	0	-29	30.0	502	30
4	m	708	0	-163	0.0	871	0	81	40.0	952	40
5	f	725	0	86	0.0	639	0	14	50.0	653	50
5	f	661	10	-114	10.0	775	0	48	50.0	823	50
7	f	626	0	-59	0.0	685	0	62	30.0	747	30
8	f	881	20	-123	-40.0	1004	60	-160	10.0	844	70
9	m	758	0	58	-10.0	700	10	359	-10.0	1059	0
10	m	763	0	60	0.0	703	0	36	0.0	739	0
11	m	711	0	73	0.0	638	0	120	0.0	758	0
12	m	1011	0	-330	0.0	1341	0	115	20.0	1456	20

13	f	793	0	97	0.0	696	0	-17	0.0	679	0
14	f	585	0	-89	-10.0	674	10	41	-10.0	715	0
15	f	1009	10	58	10.0	951	0	361	20.0	1312	20
16	f	643	20	-40	20.0	683	0	22	0.0	705	0
17	m	764	0	210	0.0	554	0	-2	40.0	552	40
18	m	598	0	4	-10.0	594	10	136	30.0	730	40
19	m	770	0	-291	0.0	1061	0	152	40.0	1213	40
20	m	1563	0	467	-10.0	1096	10	-471	50.0	625	60
21	f	841	0	5	0.0	836	0	166	40.0	1002	40
22	f	761	0	23	0.0	738	0	17	40.0	755	40
23	f	583	0	-168	0.0	751	0	7	20.0	758	20
24	f	650	0	-260	0.0	910	0	-108	30.0	802	30
25	m	609	0	-104	0.0	713	0	-14	0.0	699	0
26	m	679	20	87	-10.0	592	30	266	-10.0	858	20
27	m	1018	0	-227	0.0	1245	0	-142	0.0	1103	0

Linguistic Binaural Task - Right Hand, Right Ear

		Congruent		Facilitation		Neutral		Interference		Incongruent	
i.d.	Sex	RT	% Error	RT	% Error	RT	% Error	RT	% Error	RT	% Error
1	m	625	0	89	0.0	536	0	97	0.0	633	0
2	m	1003	0	82	0.0	921	0	90	0.0	1011	0
3	m	458	0	-72	0.0	530	0	-59	0.0	471	0
4	m	753	0	5	0.0	748	0	15	0.0	763	0
5	f	625	0	42	0.0	583	0	-4	10.0	579	10
5	f	571	0	-154	0.0	725	0	-159	0.0	566	0
7	f	626	0	-47	0.0	673	0	53	0.0	726	0
8	f	866	40	112	-20.0	754	60	96	20.0	850	80
9	m	670	0	-245	0.0	915	0	-80	0.0	835	0
10	m	820	0	77	0.0	743	0	-17	0.0	726	0
11	m	578	0	50	0.0	528	0	105	0.0	633	0
12	m	938	0	-7	0.0	945	0	-99	0.0	846	0

13	f	726	0	-10	0.0	736	0	-65	0.0	671	0
14	f	593	0	-3	0.0	596	0	7	0.0	603	0
15	f	816	0	102	-10.0	714	10	347	-10.0	1061	0
16	f	689	0	41	0.0	648	0	36	0.0	684	0
17	m	615	0	5	0.0	610	0	-44	0.0	566	0
18	m	588	0	30	0.0	558	0	60	0.0	618	0
19	m	916	0	156	0.0	760	0	95	10.0	855	10
20	m	603	0	-87	0.0	690	0	10	0.0	700	0
21	f	643	0	0	0.0	643	0	83	0.0	726	0
22	f	690	0	-13	0.0	703	0	-10	0.0	693	0
23	f	516	0	-155	0.0	671	0	77	0.0	748	0
24	f	629	10	-99	10.0	728	0	283	0.0	1011	0
25	m	661	0	5	0.0	656	0	-18	0.0	638	0
26	m	595	20	-19	-10.0	614	30	-56	-10.0	558	20
27	m	906	0	123	0.0	783	0	23	0.0	806	0

28	m	708	0	39	0.0	669	0	176	0.0	845	0
29	f	793	0	-170	0.0	963	0	168	0.0	1131	0
30	f	1346	10	244	0.0	1102	10	223	-10.0	1325	0
31	f	881	0	171	0.0	710	0	71	0.0	781	0
32	f	905	0	140	0.0	765	0	370	20.0	1135	20
Means		730	3	14	-1	716	3	59	1	775	4

Prosodic Dichotic Task - Left Hand, Left Ear

i.d.	Sex	Congruent RT	Congruent % Error	Facilitation RT	Facilitation % Error	Neutral RT	Neutral % Error	Interference RT	Interference % Error	Incongruent RT	Incongruent % Error
1	m	1186	0	185	0.0	1001	0	-46	40.0	955	40
2	m	1386	0	-65	-10.0	1451	10	-31	10.0	1420	20
3	m	646	0	-150	0.0	796	0	73	0.0	869	0
4	m	838	10	-210	10.0	1048	0	-7	0.0	1041	0
5	f	1155	0	311	-10.0	844	10	403	20.0	1247	30
5	f	1100	30	229	0.0	871	30	272	20.0	1143	50
7	f	1120	0	254	-10.0	866	10	294	-10.0	1160	0
8	f	836	40	50	-10.0	786	50	1	10.0	787	60
9	m	930	0	-18	-10.0	948	10	-3	20.0	945	30
10	m	1188	0	-75	0.0	1263	0	246	0.0	1509	0
11	m	938	0	107	-20.0	831	20	207	20.0	1038	40
12	m	1149	0	18	0.0	1131	0	145	10.0	1276	10

13	f	909	10	76	0.0	833	10	329	20.0	1162	30
14	f	790	0	-401	0.0	1191	0	-65	30.0	1126	30
15	f	1616	0	-317	-30.0	1933	30	152	0.0	2085	30
16	f	786	0	35	0.0	751	0	142	0.0	893	0
17	m	1040	0	-32	-10.0	1072	10	114	-10.0	1186	0
18	m	851	10	-80	0.0	931	10	35	-10.0	966	0
19	m	1183	0	-55	0.0	1238	0	24	20.0	1262	20
20	m	810	0	-60	0.0	870	0	186	0.0	1056	0
21	f	971	0	-219	0.0	1190	0	243	20.0	1433	20
22	f	1058	0	-25	0.0	1083	0	110	0.0	1193	0
23	f	1263	0	-116	-10.0	1379	10	27	-10.0	1406	0
24	f	948	0	-112	0.0	1060	0	194	30.0	1254	30
25	m	794	10	-111	0.0	905	10	109	0.0	1014	10
26	m	1203	0	-115	-10.0	1318	10	217	0.0	1535	10
27	m	1333	30	-28	30.0	1361	0	77	0.0	1438	0

28	m	981	0	31	0.0	950	0	324	10.0	1274	10
29	f	1276	0	125	0.0	1151	0	125	0.0	1276	0
30	f	1676	10	-139	10.0	1815	0	14	0.0	1829	0
31	f	1306	0	-225	0.0	1531	0	73	20.0	1604	20
32	f	810	20	-75	10.0	885	10	129	10.0	1014	20
Means		1065	5	-38	-2	1103	8	129	8	1231	16

Prosodic Binaural Task - Left Hand, Left Ear

		Congruent		Facilitation		Neutral		Interference		Incongruent	
i.d.	Sex	RT	% Error	RT	% Error	RT	% Error	RT	% Error	RT	% Error
1	m	1227	10	187	10.0	1040	0	-126	10.0	914	10
2	m	1311	0	-177	0.0	1488	0	247	0.0	1735	0
3	m	574	0	-122	-10.0	696	10	15	0.0	711	10
4	m	859	0	-167	0.0	1026	0	179	0.0	1205	0
5	f	776	0	-72	0.0	848	0	63	0.0	911	0
5	f	848	10	39	-20.0	809	30	-19	-20.0	790	10
7	f	775	0	-46	0.0	821	0	251	10.0	1072	10
8	f	749	60	-13	0.0	762	60	132	10.0	894	70
9	m	670	0	32	-10.0	638	10	107	10.0	745	20
10	m	1083	0	117	-10.0	966	10	328	-10.0	1294	0
11	m	728	0	-97	0.0	825	0	84	10.0	909	10
12	m	968	0	-151	0.0	1119	0	-19	10.0	1100	10

13	f	807	10	-54	10.0	861	0	162	20.0	1023	20
14	f	701	0	-149	-10.0	850	10	128	0.0	978	10
15	f	976	0	-345	-30.0	1321	30	816	-10.0	2137	20
16	f	836	0	-40	0.0	876	0	218	0.0	1094	0
17	m	731	10	-295	0.0	1026	10	-217	0.0	809	10
18	m	721	0	-78	0.0	799	0	77	0.0	876	0
19	m	1389	0	89	0.0	1300	0	-163	10.0	1137	10
20	m	825	0	-91	0.0	916	0	26	10.0	942	10
21	f	1226	10	261	10.0	965	0	153	0.0	1118	0
22	f	1186	0	235	0.0	951	0	56	10.0	1007	10
23	f	1025	0	-160	0.0	1185	0	28	0.0	1213	0
24	f	730	0	-314	0.0	1044	0	-2	10.0	1042	10
25	m	805	0	22	0.0	783	0	153	0.0	936	0
26	m	750	0	-568	-10.0	1318	10	25	-10.0	1343	0
27	m	1321	0	78	0.0	1243	0	25	0.0	1268	0

28	m	1175	10	195	10.0	980	0	134	0.0	1114	0
29	f	1006	0	-155	0.0	1161	0	24	0.0	1185	0
30	f	1291	0	-114	-10.0	1405	10	131	-10.0	1536	0
31	f	984	0	-59	0.0	1043	0	105	10.0	1148	10
32	f	846	10	170	10.0	676	0	212	0.0	888	0
Means		934	4	-58	-2	992	6	104	2	1096	8

Prosodic Dichotic Task - Left Hand, Right Ear

		Congruent		Facilitation		Neutral		Interference		Incongruent	
i.d.	Sex	RT	% Error	RT	% Error	RT	% Error	RT	% Error	RT	% Error
1	m	926	0	-329	-10.0	1255	10	309	10.0	1564	20
2	m	1479	10	105	10.0	1374	0	227	10.0	1601	10
3	m	718	0	-108	0.0	826	0	12	10.0	838	10
4	m	873	0	-176	0.0	1049	0	204	0.0	1253	0
5	f	948	10	-58	10.0	1006	0	8	10.0	1014	10
5	f	787	20	-435	10.0	1222	10	-89	0.0	1133	10
7	f	774	0	-322	-10.0	1096	10	-20	-10.0	1076	0
8	f	704	30	-16	-30.0	720	60	151	0.0	871	60
9	m	625	0	-158	0.0	783	0	214	20.0	997	20
10	m	1091	0	-112	0.0	1203	0	141	10.0	1344	10
11	m	926	0	-496	-20.0	1422	20	-470	10.0	952	30
12	m	1083	0	-59	-10.0	1142	10	-49	-10.0	1093	0

13	f	848	10	-209	0.0	1057	10	24	-10.0	1081	0
14	f	901	0	-4	-10.0	905	10	133	0.0	1038	10
15	f	1331	0	-1127	-40.0	2458	40	-958	-10.0	1500	30
16	f	716	10	-252	10.0	968	0	-48	10.0	920	10
17	m	866	0	-331	-30.0	1197	30	-81	0.0	1116	30
18	m	818	0	-117	-20.0	935	20	-108	-10.0	827	10
19	m	1264	20	224	20.0	1040	0	263	10.0	1303	10
20	m	950	10	-53	10.0	1003	0	306	10.0	1309	10
21	f	1148	0	-90	0.0	1238	0	-42	0.0	1196	0
22	f	713	0	-438	0.0	1151	0	-205	0.0	946	0
23	f	1273	0	104	0.0	1169	0	292	0.0	1461	0
24	f	941	0	-53	0.0	994	0	135	10.0	1129	10
25	m	870	0	-85	-10.0	955	10	-84	-10.0	871	0
26	m	1118	10	-342	-10.0	1460	20	267	0.0	1727	20
27	m	1314	10	-467	-10.0	1781	20	-561	0.0	1220	20

28	m	956	0	16	0.0	940	0	210	0.0	1150	0
29	f	1230	0	79	0.0	1151	0	282	10.0	1433	10
30	f	1964	20	-43	-10.0	2007	30	-308	-10.0	1699	20
31	f	1368	0	-83	0.0	1451	0	-93	20.0	1358	20
32	f	879	10	161	-10.0	718	20	177	0.0	895	20
Means		1013	5	-165	-5	1177	10	7	3	1185	13

Prosodic Binaural Task - Left Hand, Right Ear

i.d.	Sex	Congruent RT	Congruent % Error	Facilitation RT	Facilitation % Error	Neutral RT	Neutral % Error	Interference RT	Interference % Error	Incongruent RT	Incongruent % Error
1	m	858	0	-103	-10.0	961	10	161	0.0	1122	10
2	m	1616	0	193	0.0	1423	0	288	10.0	1711	10
3	m	685	0	-60	0.0	745	0	134	10.0	879	10
4	m	833	0	-73	0.0	906	0	93	20.0	999	20
5	f	808	0	-80	0.0	888	0	23	10.0	911	10
5	f	823	10	-288	0.0	1111	10	-192	20.0	919	30
7	f	804	0	-72	0.0	876	0	-38	10.0	838	10
8	f	750	40	84	-30.0	666	70	127	-20.0	793	50
9	m	651	0	-93	-10.0	744	10	70	0.0	814	10
10	m	1131	0	-155	0.0	1286	0	-118	0.0	1168	0
11	m	750	0	-93	0.0	843	0	85	30.0	928	30
12	m	1100	0	56	0.0	1044	0	116	20.0	1160	20

13	f	745	0	-150	0.0	895	0	223	0.0	1118	0
14	f	706	0	-85	-20.0	791	20	51	-10.0	842	10
15	f	957	10	-536	10.0	1493	0	733	50.0	2226	50
16	f	723	0	-10	0.0	733	0	128	10.0	861	10
17	m	811	0	-57	0.0	868	0	227	0.0	1095	0
18	m	760	0	-13	0.0	773	0	1	0.0	774	0
19	m	1028	0	-281	-10.0	1309	10	-293	20.0	1016	30
20	m	906	0	121	0.0	785	0	194	20.0	979	20
21	f	887	10	-239	10.0	1126	0	39	0.0	1165	0
22	f	1015	0	49	0.0	966	0	-20	0.0	946	0
23	f	1240	0	-78	0.0	1318	0	120	0.0	1438	0
24	f	859	0	9	0.0	850	0	-65	0.0	785	0
25	m	818	0	-198	-10.0	1016	10	-229	0.0	787	10
26	m	1333	0	80	0.0	1253	0	263	30.0	1516	30
27	m	1166	0	111	0.0	1055	0	117	10.0	1172	10

28	m	943	0	-205	0.0	1148	0	-195	0.0	953	0
29	f	933	0	-390	0.0	1323	0	-32	0.0	1291	0
30	f	1271	0	-477	0.0	1748	0	39	20.0	1787	20
31	f	1101	0	-207	0.0	1308	0	-43	0.0	1265	0
32	f	886	0	131	-10.0	755	10	245	-10.0	1000	0
Means		934	2	-97	-3	1031	5	70	8	1102	13

Prosodic Dichotic Task - Right Hand, Left Ear

i.d.	Sex	Congruent RT	Congruent % Error	Facilitation RT	Facilitation % Error	Neutral RT	Neutral % Error	Interference RT	Interference % Error	Incongruent RT	Incongruent % Error
1	m	879	0	-87	-10.0	966	10	-69	10.0	897	20
2	m	1420	10	-221	-10.0	1641	20	-146	0.0	1495	20
3	m	798	0	21	-10.0	777	10	137	0.0	914	10
4	m	977	10	-138	10.0	1115	0	71	0.0	1186	0
5	f	894	0	-223	-10.0	1117	10	73	0.0	1190	10
5	f	1211	10	-188	-40.0	1399	50	-289	0.0	1110	50
7	f	876	0	-237	0.0	1113	0	-60	10.0	1053	10
8	f	783	40	-56	0.0	839	40	86	40.0	925	80
9	m	818	0	135	0.0	683	0	179	20.0	862	20
10	m	1089	0	-184	0.0	1273	0	-50	0.0	1223	0
11	m	833	0	-13	0.0	846	0	125	0.0	971	0
12	m	1311	0	130	0.0	1181	0	104	10.0	1285	10

13	f	899	0	-52	0.0	951	0	-95	0.0	856	0
14	f	674	10	-242	10.0	916	0	406	10.0	1322	10
15	f	1401	10	-322	-10.0	1723	20	-562	50.0	1161	70
16	f	816	0	11	0.0	805	0	69	10.0	874	10
17	m	1270	0	-10	0.0	1280	0	-127	10.0	1153	10
18	m	803	10	13	0.0	790	10	163	0.0	953	10
19	m	1296	0	-242	-10.0	1538	10	-268	0.0	1270	10
20	m	1338	0	61	-10.0	1277	10	-205	0.0	1072	10
21	f	1313	0	183	0.0	1130	0	178	0.0	1308	0
22	f	1188	0	42	0.0	1146	0	137	0.0	1283	0
23	f	1364	10	28	10.0	1336	0	435	20.0	1771	20
24	f	846	0	-155	0.0	1001	0	334	10.0	1335	10
25	m	755	10	-126	0.0	881	10	185	0.0	1066	10
26	m	1108	0	-260	-10.0	1368	10	234	30.0	1602	40
27	m	1558	0	372	0.0	1186	0	487	0.0	1673	0

28	m	966	0	51	0.0	915	0	180	30.0	1095	30
29	f	1359	10	156	10.0	1203	0	21	10.0	1224	10
30	f	1946	0	-177	0.0	2123	0	-250	0.0	1873	0
31	f	1266	0	-40	0.0	1306	0	-152	20.0	1154	20
32	f	920	0	24	0.0	896	0	123	40.0	1019	40
Means		1093	4	-55	-3	1148	7	45	10	1193	17

Prosodic Binaural Task - Right Hand, Left Ear

i.d.	Sex	Congruent RT	Congruent % Error	Facilitation RT	Facilitation % Error	Neutral RT	Neutral % Error	Interference RT	Interference % Error	Incongruent RT	Incongruent % Error
1	m	743	0	-75	0.0	818	0	104	10.0	922	10
2	m	1553	10	-85	10.0	1638	0	164	30.0	1802	30
3	m	723	0	98	-10.0	625	10	96	-10.0	721	0
4	m	821	0	-97	0.0	918	0	95	0.0	1013	0
5	f	830	0	-31	0.0	861	0	102	10.0	963	10
5	f	844	10	-133	-10.0	977	20	-152	20.0	825	40
7	f	778	0	-73	0.0	851	0	143	10.0	994	10
8	f	612	60	-63	-20.0	675	80	33	0.0	708	80
9	m	759	10	37	0.0	722	10	150	30.0	872	40
10	m	871	0	-78	-10.0	949	10	229	-10.0	1178	0
11	m	726	0	17	-10.0	709	10	222	-10.0	931	0
12	m	1290	0	181	0.0	1109	0	-19	0.0	1090	0

13	f	751	0	-90	0.0	841	0	153	10.0	994	10
14	f	740	0	-15	0.0	755	0	28	10.0	783	10
15	f	908	0	-62	-10.0	970	10	292	50.0	1262	60
16	f	708	0	-100	0.0	808	0	287	0.0	1095	0
17	m	1159	0	388	0.0	771	0	136	10.0	907	10
18	m	815	0	62	-10.0	753	10	160	30.0	913	40
19	m	1168	0	-110	0.0	1278	0	-79	20.0	1199	20
20	m	934	0	-42	0.0	976	0	21	30.0	997	30
21	f	1085	0	-413	0.0	1498	0	-177	20.0	1321	20
22	f	1113	0	-62	-10.0	1175	10	-146	0.0	1029	10
23	f	1044	0	-537	0.0	1581	0	-13	10.0	1568	10
24	f	933	0	-46	0.0	979	0	-66	0.0	913	0
25	m	799	0	-17	0.0	816	0	93	10.0	909	10
26	m	886	0	-1182	-10.0	2068	10	-658	10.0	1410	20
27	m	1251	0	98	0.0	1153	0	21	10.0	1174	10

28	m	713	10	-149	0.0	862	10	165	10.0	1027	20
29	f	1013	0	-140	-10.0	1153	10	20	-10.0	1173	0
30	f	1383	0	-46	-20.0	1429	20	221	-20.0	1650	0
31	f	1106	0	45	0.0	1061	0	107	10.0	1168	10
32	f	809	0	-124	0.0	933	0	-61	20.0	872	20
Means		933	3	-89	-4	1022	7	52	10	1074	17

<u>Prosodic Dichotic Task - Right Hand, Right Ear</u>

i.d.	Sex	Congruent RT	Congruent % Error	Facilitation RT	Facilitation % Error	Neutral RT	Neutral % Error	Interference RT	Interference % Error	Incongruent RT	Incongruent % Error
1	m	935	10	-263	0.0	1198	10	97	20.0	1295	30
2	m	1390	0	-140	-30.0	1530	30	105	-20.0	1635	10
3	m	716	0	-2	0.0	718	0	60	30.0	778	30
4	m	1178	0	214	0.0	964	0	155	0.0	1119	0
5	f	830	0	-214	0.0	1044	0	12	0.0	1056	0
5	f	1060	20	103	10.0	957	10	9	50.0	966	60
7	f	929	10	-10	10.0	939	0	-5	0.0	934	0
8	f	939	50	194	-10.0	745	60	67	0.0	812	60
9	m	605	10	-40	10.0	645	0	326	30.0	971	30
10	m	944	0	-364	0.0	1308	0	340	10.0	1648	10
11	m	808	0	-223	0.0	1031	0	-19	20.0	1012	20
12	m	1268	10	-18	10.0	1286	0	-43	0.0	1243	0

13	f	935	10	-63	10.0	998	0	-92	20.0	906	20
14	f	856	0	-92	0.0	948	0	11	0.0	959	0
15	f	1344	0	-410	-20.0	1754	20	262	10.0	2016	30
16	f	783	0	13	0.0	770	0	46	0.0	816	0
17	m	1226	0	52	-10.0	1174	10	29	0.0	1203	10
18	m	836	0	43	-20.0	793	20	111	-20.0	904	0
19	m	1090	0	-413	0.0	1503	0	-303	20.0	1200	20
20	m	1123	0	0	0.0	1123	0	-38	10.0	1085	10
21	f	954	0	-607	-10.0	1561	10	-390	-10.0	1171	0
22	f	903	0	-270	0.0	1173	0	95	10.0	1268	10
23	f	1626	0	212	-20.0	1414	20	27	20.0	1441	40
24	f	1316	10	271	10.0	1045	0	-66	10.0	979	10
25	m	821	0	61	-20.0	760	20	145	-20.0	905	0
26	m	971	0	-2486	-30.0	3457	30	-1736	0.0	1721	30
27	m	1525	0	65	0.0	1460	0	-484	0.0	976	0

28	m	1126	10	271	0.0	855	10	458	0.0	1313	10
29	f	1031	0	-504	0.0	1535	0	-209	10.0	1326	10
30	f	2016	10	-154	-10.0	2170	20	307	0.0	2477	20
31	f	1405	0	407	-10.0	998	10	518	-10.0	1516	0
32	f	739	0	-246	0.0	985	0	-34	0.0	951	0
Means		1070	5	-144	-4	1214	9	-7	6	1206	15

13	f	987	10	159	10.0	828	0	-15	0.0	813	0
14	f	690	0	-115	-10.0	805	10	102	0.0	907	10
15	f	1068	0	-70	-10.0	1138	10	476	10.0	1614	20
16	f	851	0	68	-10.0	783	10	103	-10.0	886	0
17	m	818	0	-365	-10.0	1183	10	-100	0.0	1083	10
18	m	890	0	79	0.0	811	0	148	30.0	959	30
19	m	1251	0	-102	-10.0	1353	10	66	10.0	1419	20
20	m	1005	0	-316	0.0	1321	0	-236	0.0	1085	0
21	f	839	0	-67	0.0	906	0	438	10.0	1344	10
22	f	1023	0	170	0.0	853	0	196	0.0	1049	0
23	f	1266	0	-184	0.0	1450	0	-124	10.0	1326	10
24	f	823	0	-165	0.0	988	0	-47	0.0	941	0
25	m	736	0	52	0.0	684	0	130	10.0	814	10
26	m	1098	10	-14	-20.0	1112	30	-35	-10.0	1077	20
27	m	1011	0	-9	-10.0	1020	10	86	-10.0	1106	0

28	m	726	0	-142	0.0	868	0	54	20.0	922	20
29	f	1393	0	215	0.0	1178	0	-77	0.0	1101	0
30	f	1558	0	238	-10.0	1320	10	340	-10.0	1660	0
31	f	1045	0	34	0.0	1011	0	92	0.0	1103	0
32	f	716	0	11	-10.0	705	10	211	0.0	916	10
Means		956	3	-33	-4	988	7	75	4	1064	12

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