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Mismatch Negativity to Stimulus Omission ?

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Statement

I Maurice V. Gourley certify that this thesis contains no material which has been accepted for the award of any other degree or diploma in any tertiary institution and that, to the best of my knowledge and belief, the thesis contains no material previously published or written by another person, except when due reference is made in the text of the thesis.

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Maurice V. Gourley

Date ...18TH MARCH 1993...

Abstract

The present experiment explored the effects of stimulus omission on mismatch negativity elicitation under varying conditions of attention. Fifty subjects were divided into five groups based on attentional focus during stimulus presentation. The three experimental groups (all of whom received 10% omitted stimuli) included a Reading (ignore all stimuli) Group, a Counting (attend to omitted stimulus) Group, and a Passive Attend (attend to stimuli alone) Group. The two Control Groups (all of whom received 100% standard stimuli) comprised a Reading (ignore all stimuli) Group and a Passive Attend (attend to all stimuli alone) Group.

Stimuli were presented to the subjects in a single channel binaural auditory oddball paradigm. Subjects responses to the rare tones and also to the tone prior to the rare (pre) and following the rare (post) were monitored using EEG electrodes at three vertex sites (Fz, Cz, and Pz). Results indicated, (in contrast to orienting responses to omission), that there was little evidence of any mismatch negativity to omitted stimuli in any of the attentional conditions employed within the experiment.

The results did not provide any support for Näätänen's (1990) suggestion that MMN may be an integral component of, or at least associated with, the OR since both appear to be preattentive neuronal mismatch mechanisms. The results did however suggest that refractory effects occurred in Post responses to the standard stimulus immediately following an omission. In addition, there was some evidence of dishabituation in the Post responses of the Reading (Ignore) Group. Only the Counting Group exhibited a significant P300 in response to the omitted stimuli predominantly at the Cz and Pz sites. The relationship between attention and mismatch negativity and its unique response to omission are considered in light of the current findings.

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Chapter 1
Introduction I

Preamble & Outline

The last two decades have witnessed a large increase in the amount of research dedicated towards an understanding of the processes thought to underlie human cognition and behaviour. To a large extent this proliferation of research has been brought about by new technology which has facilitated the acquisition, observation and recording of human neural activity to a previously unprecedented degree.

Principal among the areas of greatest interest has been an exploration of the central neural mechanisms thought to govern such human cognitive processes as 'orienting to a stimulus' or 'attending to changes in the environment'. Cognitive psychophysiological research has employed a myriad of neurophysiological and autonomic observational techniques in order to explicate the neural processes underlying these deceptively simple human behaviours. Some of the techniques employed include; Electro-encephalography (EEG), Event Related Potentials (ERP), Brain Electrical Activity Mapping (BEAM), Computerised Axial Tomography (CAT), Magnetic Resonance Imaging (MRI), Magneto-encephalography (MEG), Heart Rate Monitoring (HRM), Respiration Rate Assessment (RESP) and Skin Conductance Response measurement (SCR).

The objectives of this paper are to examine the research which has focused on the neural processes involved in attentive and preattentive processing and the transition between these two states. More specifically, the aim is to investigate the phenomena in cognitive psychophysiology known as Mismatch Negativity (MMN) a component of ERP Processing Negativity (PN). The neural generator process underlying MMN has been posited to be one of the possible mechanisms implicated in the transition from a preattentive to an attentive state (Näätänen, 1988).

This paper will focus principally upon the auditory modality since this area has received the most attention in the literature. A theory related to MMN posited by Näätänen (1990) has attempted to integrate the preattentive mismatch process underlying the MMN process with those related to the autonomic OR. This paper will consider the possible correspondence between MMN and OR responses to stimulus deviance (in particular stimulus omission).

In order to appreciate the characteristic attributes of MMN it will be necessary, in *Chapter 1,* to first consider ERPs (of which the MMN component is but a small part). The vast body of research, providing an explanation of the characteristics of ERPs, will be briefly outlined along with a comprehensive overview of the essential characteristics of the MMN component.

In *Chapter 2*, the Orienting Response (OR) will be discussed since it has been suggested to be interrelated both with attentional processes and with the occurrence of MMN. The complimentary attributes and the incongruities between the MMN and OR neural generators will be considered.

Chapter 3, will consider the influence of both omission and attentional focus on mismatch negativity elicitation with reference to the current literature.

At present, it is considered that MMN is elicited in response to a neural mismatch between standard stimuli and a so called "deviant" stimulus. The OR of the autonomic nervous system has also been suggested to respond to stimulus deviance in a similar manner. However, although there has been some research which has addressed the OR in response to omission, there has been relatively little research undertaken to establish if stimulus omission produces mismatch negativity. Should the two events parallel one another this would provide substantial support for the suggestion that MMN and the OR are allied in some manner (or at least that they are functionally related).

Finally, in *Chapter 4,* a summary of the status of current research on the relationships between MMN and the OR, specifically in relation to omission, will be provided. This chapter will culminate in a discussion of the objectives and experimental hypotheses of the current research project.

Event Related Potentials (ERPs)

According to Shelley, Ward, Michie, Andrews, Mitchell, Catts, and McConoghy (1991) the desire to anchor cognitive theory in neurobiology has led to the use of event related potentials as a means of investigating the neural mechanisms involved in human attention and information processing. Many of the studies which have observed ERPs have examined either the characteristic components of the waveform in response to the changing stimuli which elicit them or have sought to establish the location of the neural generator which is likely to be producing them. ERPs have been targeted specifically since they may reveal the nature, timing, and duration of the various stages of stimulus processing.

ERPs are observed using an electroencephalograph with surface electrodes connected at strategic cranial sites appropriate to the modality of stimulus being presented. Typically, in auditory paradigms, the vertex sites including Fz, Cz, and Pz are measured concurrently. The ERP components are usually classified according to polarity, latency, site and amplitude of waveform. The ERP waveforms are revealed by averaging pre-selected stimulus intervals. These recording epochs are time-locked to be in precise synchrony with stimulus presentation (Näätänen, 1982).

According to Hillyard and Hansen (1986) the characteristic waveforms can be described as a series of components or peaks and troughs which occur at characteristic latencies. An ERP consists of both positive and negative deflections which reflect the degree of brain activity during the recorded epoch (Näätänen, 1986b). Using experimental manipulations it is possible to disentangle the separate components of the ERP waveforms which are thought to reflect the operation of distinct neural processes within the brain (Näätänen, 1986b).

Gaillard (1988) and Näätänen (1990) suggested that the ERP waveform components are usually classified as either endogenous or exogenous (predicated on the degree of influence of the external stimulus eliciting the organisms response). If a response is evoked by the characteristics of a stimulus outside the organism (such as pitch, frequency, duration, etc.) then the ERP component is said to be exogenous. Gaillard (1988) suggests that the endogenous components of the ERP are generally considered to be largely independent of the stimulus presented and principally the result of an internal, psychological, comparator process (Sams, Alho, & Näätänen, 1985). We shall see however that this latter assumption has not always been supported since some external factors, such as focused selective attention, do appear to influence ERP endogenous components (Woldorff, Hackley, & Hillyard, 1991). Hillyard and Hansen (1986, p.228) issue a warning regarding interpretation of the ERP waveform;

> In seeking relationships between ERPs and psychological processes, it is certainly an oversimplification to consider an ERP as a linear sequence of discreet components. Each peak or valley in the ERP probably reflects the activity of many different neural systems operating in parallel, and there is no reason to suppose that these peaks reflect more important neural events than do intermediate points.

The ERP typically has several components each of which are considered to represent different stages of stimulus processing. The most researched components include; the N1 component thought to index early sensory processing; the N2 component thought to be comprised of two parts: the N2a (MMN) which is preattentive (Näätänen, 1986b; Näätänen & Gaillard, 1983; Näätänen, Gaillard, & Mantysalo, 1978); and the N2b which is thought to be attentive (Näätänen & Gaillard, 1983) and associated with the later component in issuing a 'call' for further processing and the P300. Other components, less frequently studied, include the N400, the late positive component (LPC), and P2. The ERP component of current interest is the N2a or MMN component to which we now turn.

Mismatch Negativity (MMN)

What is MMN ?

Mismatch negativity may be construed as the processing negativity which is exhibited by an organism when a novel or deviant stimulus is presented amid a usually constant (homogenous) stream of standard stimuli (Sams et al., 1985). According to Näätänen (1986b) it reflects a cerebral process which is specific, not to the presenting stimulus per se, but rather, to *stimulus change* . Näätänen (1986b) argues that a stimulus cannot elicit a response from this neural population without there first being a preceding 'different' stimulus. This deviant stimulus must be physically different from the standard stimulus since other forms of stimulus deviance do not appear to elicit the MMN (Näätänen & Gaillard, 1983; Novak, Ritter, & Vaughan, 1992). MMN is purported to occur in response to a deviant stimulus irrespective of whether the stimuli are attended to or not (Näätänen & Gaillard, 1983) (although, according to Näätänen and Lyytinen (1989) MMN is best observed in the ignore condition because there is no overlapping N2b component).

In the preceding discussion one must remain cognisant of the fact that this postulated definition is still somewhat tenuous since recent findings by Woldorff et al. (1991) suggest that MMN, previously considered to be preattentive and quite independent of external attention (Näätänen et al., 1978; Näätänen, Gaillard, & Mantysalo, 1980; Sams, Alho, & Näätänen, 1984; Sams, Paavilainen, Alho, & Näätänen, 1985), may be less independent than had been previously thought. Woldorff, et al. (1991) were able to establish that MMN to an auditory deviant stimulus was significantly attenuated when a strong auditory attentional focus was imposed upon the subject. This latter finding has called into question the validity of MMN, as reflecting a wholly preattentive cognitive process unaffected by external influences and significance.

ERP Negativity Relationships

Mismatch Negativity is but one aspect of a series of ERP processing negativity components. According to Gaillard (1988) the classification of processing negativity is a somewhat slippery concept to grasp since the literature seems replete with many, often contradictory, negativity constructs. Among these are the following negativity terms; PN, Nd, N1, N2, N2a, N2b, N200, MMN and N400. All of these terms apparently qualify as a processing negativity yet differ in definition and/or purported function (or mean the same thing as is the case with MMN and N2a) (refer to Gaillard (1988) for a more comprehensive discussion of this issue). The emphasis in this paper is upon MMN, N2a, N2b and P300.

Both the N2a and N2b components are thought to constitute the various aspects of preattentive and attentive auditory processing. The N2a or MMN component is thought to index preattentive, automatic neural processing (Näätänen, 1986b; Näätänen & Gaillard, 1983; Näätänen, et al., 1978) whereas the N2b component, and the subsequent P300 waveform with which it seems inexorably connected (Näätänen & Gaillard, 1983), are suggested to index conscious, focused, voluntary attention. On balance, the literature refers to MMN as synonymous with the N2a component.

Response Attributes of MMN/N2a

Mismatch negativity is currently thought to be generated only when a mismatch occurs between the neuronal representation (or trace) of the frequent repetitive (standard) stimulus and a deviant stimulus (Näätänen, 1988). Auditory MMN appears to be sensitive to single or multiple aspects of stimulus deviance including; frequency, intensity, duration and location (Näätänen & Gaillard, 1983). MMN is also dependent upon the magnitude of the physical stimulus deviance, that is, MMN latency may increase or decrease depending on the extent of the differences between standard and deviant stimuli (Näätänen & Gaillard, 1983). This distinction does not however appear to apply to stimulus omission as Robinson (1991) and Martin, Siddle, and Robinson (1992) failed to find MMN to an omitted auditory stimulus.

One study has considered how well the MMN generator can tolerate small changes in the standard stimulus before resorting to identifying them as deviant. Winkler, Paavilainen, Alho, Reinikainen, Sams, and Näätänen (1990) varied the frequency and intensity of the standard auditory stimuli presented to the subjects. It was demonstrated in this experiment that MMN was still elicited to the deviant stimuli irrespective of the intensity and frequency variation of the standard stimuli, (although in some cases the amplitude was somewhat attenuated). According to Winkler, et al. (1990) this demonstrates that the MMN generator process is likely to be activated in ecologically more valid circumstances as well as in the experimental situation.

The response attributes of MMN appear to suggest that the neuronal representation of the standard stimulus is maintained in the brain for relatively short durations. This discovery has been established by altering the Inter Stimulus Interval (ISI) between standard stimulus presentations. Mantysalo and Näätänen (1987) presented auditory stimuli at four different ISIs (1,2,4,8 sec). The results of this study showed clear evidence of MMN at the two shorter ISIs but no evidence of MMN at the two longer ISIs. Thus it was concluded that the duration of the neuronal trace was limited to under 4 seconds.

Stimulus duration is also known to influence the degree of MMN exhibited. As the duration of the stimulus is increased the MMN exhibited also increases suggesting that the longer duration stimuli may produce better neuronal traces (Näätänen, 1986b).

Temporal Attributes of MMN/N2a

The neuronal representation (or trace), which may best be conceptualised as a sensory register or preattentive store (Näätänen, 1988; Näätänen, 1986a), is generated quite rapidly (after only a few repetitions of the standard stimulus (Sams, et al., 1984)). The onset latency of an auditory MMN occurs at around 100-150ms following stimulus onset and is characterised by a negative going potential of some 3 to 4µV (although this is dependent, to a large extent, on the stimulus modality presented, the magnitude of the deviant stimulus, and the ISI) (Näätänen, 1986a). With auditory stimuli MMN amplitude reaches its peak at around 200–250ms following stimulus onset (Giard, Perrin, Pernier, & Bouchet, 1991; Näätänen & Gaillard, 1983). Typically the amplitude of MMN increases rapidly and then levels off to a plateau (Graham & Hackley, 1991).

Location of MMN Generators

Much of the knowledge about the physiological mechanisms involved in producing MMN rests upon the evidence produced by topographic studies of the neural structures active during MMN elicitation. From these studies several possible locations of MMN generators have been posited (Giard, et al., 1991). Several topographic studies suggest that the generators controlling MMN are modality specific (Simson, Vaughan, & Ritter, 1977; Näätänen & Gaillard, 1983; Nyman, Alho, Laurinen, Paavilainen, Radil, Reinikainen, Sama, & Näätänen 1990). Generally, at least in the auditory modality, the findings suggest a maximal focus over the fronto-central areas of the scalp (Näätänen & Gaillard, 1983; Näätänen, 1990) and also at least partly in the primary auditory cortex (or in its immediate vicinity) (Winkler, et al., 1990; Näätänen, 1990)

More recently studies using magnetoencephalography (MEG) have found that the negative wave elicited by the deviant stimuli exhibited the highest amplitude over the right hemiscalp irrespective of the ear of stimulation (Giard, et al., 1991). Giard, et al. (1991) conducted two experiments to establish the possible location of MMN generators. The outcome of these studies are consistent with the idea that more than one generator process may be involved in MMN. Their findings reveal both temporal and frontal generators associated with MMN elicitation (Giard, et al., 1991). Interestingly, some researchers have suggested that it is likely that multiple neuronal traces of standard stimuli may in fact operate in parallel (Sams, et al., 1984) and simultaneously contribute to the mismatch process (Winkler, Paavilainen, & Näätänen, 1992).

The preceding discussion appears to provide at least tentative support for the argument that the N2a component is the output of a functional neuronal mismatch generator which may initiate a 'call' for focal processing (Öhman, 1979). The second N2 component, presumably the N2b/P3 complex, might be elicited when the call process succeeds in switching attention to the deviant stimulus (Näätänen & Lyytinen, 1989). Additional research is needed however to clarify these assumptions. As Näätänen and Gaillard (1983) point out it is not always possible to decompose the N2a and N2b components, often, the two appear to merge in a predominantly fronto-central distribution.

Habituation, Dishabituation and Refractoriness of the MMN Component

Research into the habituation and dishabituation characteristics of the MMN component of the ERP suggested that MMN is susceptible to short term habituation and dishabituation (Sams, et al., 1984). However, this suggestion has, at best, equivocal support. Some researchers point out that some response decrements might more appropriately be construed as a refractory process rather than a true habituation process (Graham & Hackley, 1991). The refractory process is considered to be one of sensory adaptation or fatigue rather than of learning origin as is the case with habituation. More specifically, the distinction between the two is that simple repetition rate effects are considered to be due to refractoriness while those decrements due to learning are considered to represent habituation (Graham &

Hackley, 1991). Dishabituation is an increase in responding following a change from an habituated stimuli and has been shown in some studies to occur in the ERP if the stimulus following the deviant stimulus was unattended (subjects reading a book) (Martin et al., 1992; Robinson, 1991).

It has been argued then that MMN processes bear a striking resemblance to certain aspects of the OR. The issue of the relationship between these two neuronal response mechanisms will be considered in the next chapter together with a brief overview of the orienting response (OR).

Chapter 2
Introduction II

The Orienting Response

According to Näätänen (1986b) recent ERP research has identified a process not unlike that involved in eliciting an OR. Specifically, it is suspected that MMN (together with the N2/P3a complex) may, in some manner, be involved with the initiation of the OR (Näätänen & Lyytinen, 1989). Graham and Hackley (1991) suggest that although MMN cannot be considered an OR component it is frequently followed by an N2b/P3a which does exhibit similar functional characteristics to the OR. This section will briefly review the basic characteristics and models of the orienting response and then consider its relationship to MMN more fully.

A definition of the Orienting Response

The OR has been defined as a complex of both behavioural and physiological responses which are produced by the individual in response to a novel stimulus change (Sokolov, 1963b; Siddle, 1991). The purpose of the OR is to produce elevated attention and alertness to permit optimal assessment of the eliciting stimulus (Spinks & Siddle, 1983). This definition, as we shall see is still somewhat controversial since it is purported to ignore important aspects of OR elicitation. The OR, by definition, represents an early stage of information processing (Näätänen, 1986b). It is suggested to be the primary mechanism by which we orient toward a target of interest (or threat) prior to developing any cognitive strategy for assessing it (Näätänen, 1986b). It is therefore a crucial process in shifting from preattentive to attentive status. Some researchers argue that, to a large extent, the OR may represent attentional processes, in particular, those related to passive attention to input (Graham & Hackley, 1991). Other theorists suggest that the OR represents a 'call' for processing which is therefore largely preattentive (Öhman, 1979).

The process of orienting appears to be very rapid, which is as might be expected given its functional role of alerting the organism. The terms frequently employed by researchers to describe the OR, according to (Näätänen, 1986b), include the "Investigatory Reaction", the "What-is-it" response or the "Orienting exploratory reflex".

Effects of the OR

An OR, initiated by a novel *perceived* stimulus *change* (with 'perceived change' being the operative term), produces a characteristic train of physiological, postural (although postural change is frequently challenged as not constituting part of the OR (see; Graham and Hackley (1991)) and autonomic nervous system reactions. Näätänen (1986b) has suggested these fall into two categories of response. First there are those responses directed towards an *attentional* shift, and secondly, there are those directed towards physical *arousal*. These reactions are both dedicated towards directing the individuals maximal processing resources towards the stimulus and preparing the individual to physically cope. Näätänen (1986b) suggests these two patterns constitute an "attentional-arousal" response pattern.

Basically, the individual displays the following during an OR: a cessation of current activities, an inclination of the primary receptor organs towards the stimulus, a general elevation of muscle tone, the sensitivity of the sense organs is magnified, pupillary dilation occurs, and the EEG changes to a low amplitude and fast rate waveform suggestive of increased arousal (Lindsley, 1960, 1961 cited in Näätänen, 1986). In addition to these changes Näätänen (1986b) also points to changes in heart rate (deceleration), respiration, and the presence of a GSR - Galvanic Skin Response.

Observation of the OR

The OR, as indicated earlier, may be detected by employing physiological measures of the autonomic nervous system and periphery. Monitoring of heart rate, GSR, or respiration are typically undertaken in research to establish OR elicitation. The OR is frequently studied by exposing the subject to a repetitive stimulus with long ISIs (sufficient to allow measurement of the slow autonomic responses) (Näätänen & Lyytinen, 1989; Näätänen & Gaillard, 1983).

According to Näätänen and Lyytinen (1989) a large OR is generally evident to the first stimulus presentation but this is quickly habituated (Näätänen & Gaillard, 1983). When the subject is then presented with a secondary rare or deviant stimulus or some feature of the original stimulus is modified then a marked autonomic nervous system (ANS) change is evidenced - the OR. The OR to the first stimulus is often referred to as the 'Initial OR' and the OR to the changed stimulus the 'Change OR' (Barry, 1984; Kenemans, Verbaten, Roelofs, & Slangen, 1989; Näätänen & Gaillard, 1983).

The OR is not modality specific since it can be observed in a variety of response modalities. According to Siddle, Stephenson, and Spinks (1983) it may be readily elicited in response to a variety of stimulus attributes such as either to stimulus onset or offset, and either to reduced or elevated stimulus intensity. Siddle and Spinks (1979) suggest that the amplitude of the OR is dependent on stimulus change with frequent repetition of a stimulus leading to habituation and presentation of a rare or deviant stimulus producing a recovery of response. In addition, it is not the quality of the stimulus itself which elicits the OR but rather any *change* in stimulation with a low probability of occurrence (Graham & Hackley, 1991). We shall see in later discussion that this latter view is challenged by some theorists.

Theoretical perspectives on the OR

Theoretical explanation of the OR mechanism and its principal function has culminated in several principal theoretical orientations toward the OR. This paper will be concerned primarily with two of the comparator models. Firstly the Stimulus Comparator theory of Sokolov (1963a) and secondly an opposing view which modifies the comparator model in favour of an information processing model (Öhman, 1979). The latter model has also been modified somewhat by other researchers. Both of these perspectives will be considered briefly here.

The Sokolov OR Neuronal Mismatch Model
A Stimulus Comparator Model

Sokolov (1963a) proposes that the OR mechanism constitutes the operation of a neural comparator process. When the organism is initially presented with a stimulus, a representation, or as Sokolov calls it a 'neuronal model', of the stimulus is committed to memory. This neuronal representation of the repetitive stimulus then acts as a template against which all subsequent income is compared. The model proposed by Sokolov (1963b) consists of internal representations of the peculiar characteristics of the repeated stimuli such as intensity, temporal presentation, sequence and pattern of presentation.

When the next stimulus is presented the comparator references it to the neuronal model. If the presenting stimulus is identical to the neuronal model then no output is generated from the comparator mechanism - and consequently no OR. If however the stimulus characteristics have changed and the comparator identifies a mismatch between its characteristics and the neuronal model then an output is generated from the comparator resulting in the elicitation of an OR (Näätänen, 1986b).

Sokolov (1963b) provides neurological evidence for his theory through microelectrode studies with rabbits indicating the likely location of comparator mechanism in the hippocampus.

However, to date, little information is available which describes similar mechanisms within humans (Näätänen, 1986b).

Sokolov (1963a) theory has been widely disputed as a sufficient explanation for the OR since it considers only the stimulus attributes in accounting for its elicitation. According to Näätänen (1986b) Sokolov's model has been called into question by many researchers in light of the argument that the OR is not simply elicited to stimulus change but, more importantly, to the 'significance of the change' to the organism. When stimulus significance is introduced within an experiment such that the subject must attend to the deviant stimulus the resulting OR is enhanced. The significance hypothesis then considers that the OR is not simply stimulus specific but that cortical interpretive and evaluative processes must precede the OR elicitation (Näätänen, 1986b). Näätänen (1986b) however does not necessarily subscribe to this perspective since much of the current MMN results suggest the OR may be elicited to stimulus change irrespective of psychological processes and significance issues - thus neuronal mismatch alone seems to be sufficient for eliciting the OR (Näätänen & Gaillard, 1983; Näätänen, 1986a).

Öhman's (1979) Orienting Reflex Model
An Information Processing Theory

Öhman (1979) has proposed that several issues need to be challenged in Sokolov (1969) model of the orienting response. First, clear distinctions need to be made between the initial (preattentive) processing of a stimulus and the more in-depth controlled processing which is "selective and resource limited" (Öhman, 1979, p. 444). Secondly, the memory store is a limited capacity carrier and at any given time has only limited resources available for processing (the available component being the STM store, whereas the LTM store is largely unavailable). Finally, Öhman (1979, p.443) proposes that given the aforementioned points the OR is elicited when the preattentive mechanisms fail to establish a match for the incoming stimuli in short term memory and that this should be construed rather as a **'call'** for controlled processing within a central, capacity limited channel.

Öhman's (1979, p.444) model proposes that stimuli can be accepted into the focal processing channel in two ways;

> When the preattentive mechanisms fail to identify a stimulus because there is no matching representation in short term memory a non-signal OR is elicited and the stimulus is admitted into the central channel. Alternatively, a stimulus can elicit an OR because it matches a memory that has been *primed* as "significant" and then the stimulus enters the central channel for further processing.

Öhman (1979) has suggested that the depth to which a stimulus is processed predicts its likelihood of storage in long term memory, thus deviant stimuli of low probability are more likely to receive additional processing than a repetitive stimulus. According to Öhman's (1979) model the OR constitutes an essential prerequisite for learning and for integration of stimuli into LTM and this is the mechanism by which individuals learn about unexpected and surprising events. Thus Öhman's (1979) model emphasises the preattentive nature of the OR and its relationship to controlled processing within the central channel.

Mismatch Negativity & the Orienting Response

According to Näätänen (1990) and Näätänen (1986b) the process generating the MMN component of the ERP bears a striking resemblance to the neuronal mismatch proposed by Sokolov (1963a) and Sokolov (1975). Näätänen (1988) has hypothesised that MMN reflects an acoustic-specific trigger or call for controlled processing and, although not a true OR component on its own, when coupled with the N2b/P3a complex does show similar functional characteristics of an OR. In addition, Graham and Hackley (1991) have suggested that MMN might represent, either directly or indirectly, an automatic OR trigger. It is also possible that MMN precedes the OR and in some manner acts as part of the preattentive mechanisms posited by Öhman (1979). This suggestion has received some support from Nyman et al., (1990). However the evidence for this argument to date is still relatively meagre.

Graham and Hackley (1991, p.335) have proposed a tentative model to explain the relationship between mismatch negativity and both Sokolov's and Öhman's theories of orienting;

> Delivery of a stimulus deviating from a model along physical or temporal dimensions evokes a specific-modality mismatch negativity in the ERP. If the deviance from expectations exceeds a threshold, a request is automatically issued for additional processing resources. This call is mirrored in N2b-P3a and in ANS-OR components. If the request is granted, sensory processing in general is enhanced and may include further processing of the input, reflecting prolonged heart rate deceleration and perhaps further negativity in the ERP, and/or an effortful search of long term memory and encoding of the stimulus into memory, reflected in heart rate acceleration and P3b.

Näätänen (1986a, p.72) offers similar suggestions regarding the relationship between MMN and the OR;

> Hence, it is suggested that any neuronal mismatch leads to automatic orienting kinds of changes such as transient increases in spinal excitability and reticular and thalamic (non-specific nuclei) arousal with their typical widely spread reflections in different functional systems of the organism.

Näätänen (1986a) goes on to point out that the "significance" of the mismatch process then become paramount in determining if further orienting occurs. Näätänen (1986a) suggests that the P3 component is important in this latter instance since the bulk of evidence suggests that P3 is elicited only in circumstances where the stimulus has some clear significance to the organism.

Is the MMN of the ERP the same as the Mismatch Process of the OR ?

Although there are many obvious parallels between the mismatch process of the OR and the MMN of the ERP, it is still relatively unclear whether the two mechanisms are functionally related (Näätänen & Gaillard, 1983; Graham & Hackley, 1991). However, there is some congruence between MMN measures and the accompanying occurrence of autonomic nervous system (ANS) activity, suggestive of orienting reflex activity, however these findings are by no means unequivocal. For example, research conducted by Lyytinen, Blomberg, and Näätänen (1992) suggested that, in short ISI conditions at least, MMN can be elicited without any resultant OR elicitation.

Näätänen and Gaillard (1983) in their consideration of the relationship between MMN and the OR suggest that the two processes do appear to have much in common. In particular the N2b/P3a components of the ERP bear a strong resemblance to the OR. Näätänen (1986a) after reviewing the outcomes of several ERP studies concluded that MMN may be valuable as a non-invasive measure of the neuronal mismatch of the OR thus providing a bridge between cognitive research and psychophysiological research.

Näätänen and Michie (1979) have suggested that, on the basis of current research and topographic studies, it appears likely that 'processing negativity' of which MMN is a part, jointly reflects both the orienting to a relevant stimulus and its further processing. This suggests then the activity of two generator systems: one principally dedicated to orienting the individual and the other involved in further stimulus processing. This concept is supported by the findings of Giard, et al. (1991) who suggests that MMN generators appear to be active both frontally as well as in the auditory cortex. According to Giard, et al., (1991) it is this frontal component that is related to orienting.

As indicated earlier, there is some evidence to suggest that orienting type autonomic responses can accompany MMN immediately following slight changes in the irrelevant input. Lyytinen and Näätänen (1987) found that when there were even slight changes in irrelevant input this tended to elicit both MMN and an ANS reaction suggestive of a shift in attention. It was also found that a shift in irrelevant input could also be made without any associated ANS response - it was assumed in this case that the shift in attention may have failed to occur (Lyytinen & Näätänen, 1987). This lends some weight to the suggestion that MMN and the OR may be somehow connected with each other. Näätänen (1990) also points out that MMN tends to be followed by the P3a component which could be construed as a sign of activation of an attention-switching mechanism.

Principal Differences between MMN and the OR

One of the obvious differences between MMN and the OR has been discussed by Nyman et al. (1990) who point out that there are pronounced differences in the onset latency and duration of effect between MMN and the OR. Typically, MMN (at least in the auditory modality) is observed to commence at around 70-150ms from the onset of the deviant stimulus (Nyman, et al., 1990) whereas the OR (Skin Conductance Response (SCR)) is observed to commence, at the earliest, around 200-300ms (Nyman, et al., 1990). In addition MMN lasts only for some 100ms whereas the OR peaks at around 500-1500ms (SCR) (Nyman et al., 1990). Nyman et al. (1990) suggest that this indicates that MMN and the OR are unlikely to be produced by the same processes but perhaps MMN may precede the OR and be a necessary mechanism in its elicitation.

Another difference between MMN and the OR lies in the anomaly between their habituation and dishabituation characteristics. According to Sams, et al. (1984) MMN is susceptible only to short term habituation and dishabituation whereas the OR is susceptible to rapid habituation and dishabituation (Graham & Hackley, 1991).

Of particular note are the differences in specificity between the OR and MMN. Much of the early research suggested that

MMN was modality specific (predominantly seen in the auditory modality) (Graham & Hackley, 1991). This point of view has changed somewhat to acknowledge the possibility of inclusion in other modalities (Näätänen, 1990; Dobber, 1992). However, it has been suggested for some time that the OR is multi-modal and can be elicited to visual, auditory or somatosensory stimuli.

A major challenge in establishing any relationship between MMN and the OR concerns the differences between the measures employed in OR research and those used in ERP/MMN studies. As previously suggested, there are substantial differences in response latency with MMN exhibiting short latencies and the OR measures exhibiting long latencies (Näätänen, 1979). These differences in response latency make it difficult to make direct comparisons between the cerebral events of MMN and the autonomic responses of the OR (Näätänen & Gaillard, 1983) (although this has been attempted by some researchers (see; Näätänen and Lyytinen (1989)).

A further obvious difference identified by Näätänen (1986b) is that MMN is normally not elicited to the first stimulus in a series whereas it is in an OR. This suggests that there may be two OR generators, one for the "Initial" stimulus and one for the "Change" stimulus. Näätänen and Gaillard (1983) postulate that it is possible to distinguish the change OR from the initial OR via psychophysiological measures. The change OR appears to be indexed by the MMN component while the initial OR is indexed by the N1 component of the ERP.

Finally, there are differences in the location of cerebral generators for the OR mismatch process and the MMN component of the ERP. The OR mismatch process has been purportedly located in the hippocampus (Sokolov, 1975) while MMN research as discussed earlier indicates a focus predominantly in the auditory cortex. This discordance has now been ameliorated to some extent since recent topographical studies have provided evidence that MMN generators may also be located in other regions of the brain including the hippocampus (Näätänen & Lyytinen, 1989).

According to Näätänen (1986b) although there are similarities between MMN and the OR mismatch process there are also some profound differences. Graham and Hackley (1991, p.283) argue that;

> These differences between functional characteristics of the neuronal model inferred from MMN and from ANS orienting responses are consistent with differences in the presumed loci of the models; that is, with a sensory-specific locus for a sensory-specific model, on the one hand, and a locus in an integrational area (eg: amygdala-hippocampus), on the other hand .

Granted there are profound differences it is still possible that MMN represents an integral constituent of the OR mismatch process. Additional research identifying the incongruities between the two is needed to tease out the role of MMN in the OR (and also the possibility of multiple MMN generators being involved in the elicitation of the OR).

One such incongruity relates to the elicitation of the OR in response to stimulus omission. Sokolov (1963b) has suggested that the OR can be elicited to omitted stimuli (this viewpoint has been accepted by many researchers, according to Barry and O'Gorman (1987), but is challenged by others). While there has been a great deal of research into the effects of stimulus omission on the OR there has been a relative dearth of research considering its effects on the elicitation of MMN. The next chapter will consider the effects of stimulus omission and attention on both the OR and MMN in an attempt to identify a bridge between the two responses systems. If it is possible to identify similarities in omission response characteristics between the OR and MMN this would represent significant theoretical support for a common reciprocity between the two.

Chapter 3
Introduction III

Influence of Omission on the OR

Much of the available literature on the effects of stimulus omission relate to its influence on the elicitation of the OR (O'Gorman & Lloyd, 1976; Siddle, 1985; Siddle & Heron, 1975). On balance the research appears to support the notion that the OR is sensitive to omitted stimuli. However, as previously suggested, according to Barry (1984) and Barry and O'Gorman (1987), current research provides only equivocal support for this suggestion since there have been wide variations in subject outcome in many of the studies undertaken to date.

Barry (1984, p.535) argues that although the OR seems responsive to omission the "phenomena is relatively fragile". Siddle and Heron (1975) also reach this conclusion in light of research suggesting that electrodermal omission ORs also appear to be a somewhat unstable phenomenon. It has been argued that the OR response to stimulus omission has erroneously been attributed to an involuntary effect rather than a voluntary one (Barry & O'Gorman, 1987; Maltzman, 1979).

Influence of Omission on MMN

Very little research has been undertaken to establish the effects of stimulus omission on the elicitation of MMN. Much of the early ERP research, such as that undertaken by Picton and

Hillyard (1974), was directed more towards establishing the effects of omission on other ERP components such as N1, P1, and P300. One early study Klinke, Fruhstorfer, and Finkenzeller (1968) considered the effects of stimulus omission on somatosensory ERP elicitation finding that the omitted stimuli produced a small negative wave maximal at 200-240 ms. The authors however did not identify this as MMN.

More recent research (Martin et al., 1992; Robinson, 1991) has employed an auditory "oddball" paradigm with a binaural stimulus presentation of either a continuous standard tone alone, a deviant pitch or stimulus omission (all subjects read a book during stimulus presentation and were instructed to ignore the presented tones). The findings in these studies suggest that MMN was elicited normally to the pitch deviant stimuli (in agreement with previous research) but was not elicited at all in response to the omitted stimuli. The authors suggest that this may be because stimulus omission may not constitute *physical* stimulus deviance (Martin et al., 1992; Robinson, 1991) as is suggested to be necessary for the elicitation of MMN (Näätänen & Gaillard, 1983; Graham & Hackley, 1991). This absence of a physically deviant stimulus fails to register as a mismatch in the neuronal store and MMN is prevented (Robinson, 1991).

Support for the presence of MMN to omission is likewise meagre. One study by Ullsperger, Gille, and Peitschmann (1985) used tone pairs and tone triples from which one component of the triple was omitted. Their findings suggested some evidence of N2 negative deflections in response to the omission of one component of the tone triples. However, it must be borne in mind that the experimental omission conditions were not strictly omission since only a portion of the stimulus train was omitted. In addition, the authors point out that the negative deflections observed could not be identified as MMN.

More recent research by Tervaniemi, Saarinen, Paavilainen, and Näätänen (1993), using similar methodology to the previous study, suggests that MMN was elicited when the order of presented tones was reversed or when the second stimulus of a stimulus pair was omitted. These researchers presented a tone pair formed by two closely paced tones of different frequencies. They then either reversed the order of the tones or omitted the second tone. Both of these stimulus conditions apparently elicited MMN. Once again, only a portion of the stimulus train was omitted therefore the occurrence of true omission is questionable. The findings of the latter studies, where stimulus trains were used, seem to support the suggestion that a 'physically' deviant stimulus is necessary for the elicitation of MMN since in all conditions there was a physical stimulus. That is, it could reasonably be argued that in the condition where the second tone was omitted the deviant stimulus simply became physically shorter (in time). If this is true then the use of the term 'omission' in paradigms such as this is perhaps ambiguous.

The Influence of Attention on MMN

According to Graham and Hackley (1991) the term attention is a "fuzzy" construct which has yet to secure its position within a comprehensive theory of information processing. Graham and Hackley (1991) suggest the term refers to an internal, central, process which benefits sensory reception and perception.

Characteristic Components of Attention

There are several characteristic components of attention identified in the literature which are pertinent to the mismatch negativity component of the ERP. Attentional descriptors often employed include the following; passive or involuntary attention; and active, voluntary or controlled attention. The distinction between these components of attention is not always clear. This paper is concerned primarily with the voluntary/involuntary attentional distinction.

Involuntary attention is suggested by some researchers to represent the organisms response to sudden changes within a constant environment. The individuals attention is drawn to a stimulus by virtue of its salience (Näätänen, et al., 1980), that is, the stimulus is the initiator of the attentional action rather than the organism. This form of attention is suggested by some researchers to be closely related to the OR (Sokolov, 1975).

In contrast to the latter definition, *voluntary attention* is initiated by the organism itself and is in this sense 'controlled' attention. The organism selects the stimulus on which to focus on the basis of motive, self instruction or when directed (Näätänen, et al., 1980). Thus the individual selects the stimulus on the basis of its significance (selective attention).

Attention is an integral component of most cognitive processes in most modalities. It has also been shown to be a crucial outcome of the OR. There are several categories of attention referred to in MMN research including; passive attention, active attention, focal attention, divided attention, and selective attention.

Theories of Attention

Näätänen (1988) has provided a review of the theories of attention relevant to MMN. Two main attentional theories were identified by Näätänen (1988): selective attention (focused) and divided attention. *Selective attention* research has its main focus on the individuals ability to "tune out" or resist distractions and also to determine the threshold at which attention is disengaged from distractive stimuli (Näätänen, 1988). *Divided attention* research has been directed towards an exposé of the limits of performance by seeking to establish which tasks can be undertaken without loss (Näätänen, 1988).

Automaticity of Processing

One of the central issues in MMN/attention research has been the issue of automaticity in processing. Kahneman and Treisman (1984) (cited in Näätänen (1988:p.119)), have made a distinction between:

> *Strong automaticity* (where an act of perceptual processing is neither facilitated by focusing attention to the stimulus, nor impaired by diverting attention from it); *Partial Automaticity* (where an act is normally completed even when attention is diverted from the stimulus, but can be facilitated by attention); *Occasional Automaticity* (where an act generally requires attention but can sometimes be completed without it).

Näätänen and Lyytinen (1989) has suggested that MMN because of its largely preattentive qualities (i.e.; strong automaticity) is particularly valuable as a means of assessing the automaticity in auditory sensory processing. Automatic involuntary attention is considered by Näätänen, et al., (1980) to be closely related to the processes initiating the OR.

The Attentional Trace (Näätänen, 1988)

Näätänen (1988) alludes to the existence of the theory of an "attentional trace". This theory implies that some internal neurophysiological representation of a selected target stimulusx must exist within the individual to permit discrimination between target and non-target stimuli. That is, if we ask a subject to attend only to the deviant stimuli within a series of homogenous repetitive stimuli then some representation of the deviant stimuli must exist for this selection process to occur. Näätänen (1982) suggests this attentional trace is developed and maintained in the organism as a "precise mental image" of the target stimulus. It takes only a few presentations of the target stimulus for the attentional trace to be strengthened.

According to Näätänen (1982) the trace exists only as long as the individual maintains this image as the prime focus of consciousness. It is thus presumed that the attentional trace is under the voluntary control of the individual. Thus the attentional trace, according to Näätänen (1988), represents a flexible and efficient but high-cost neural mechanism used for fast recognition, discrimination and related operations.

Role of Attention in Mismatch Negativity Elicitation

Attention is suggested not to influence the elicitation of the MMN component of the ERP. Näätänen (1988) suggests that the main feature of interest in MMN research is its apparent independence from attentional influence. Similar MMN waveforms have been elicited to both attended and unattended (relevant and irrelevant) stimuli (Näätänen, et al., 1978; Mantysalo & Näätänen, 1987). As indicated in Chapter 1 this theory is now being challenged by recent studies which have demonstrated that MMN can be attenuated by a strong attentional focus away from the deviant stimuli (Woldorff, et al., 1991).

Event related potential research has been predominantly concerned with active attention mechanisms according to Graham and Hackley (1991). However, most recently research has considered the effects on MMN of both active and passive attention. MMN has been studied within a variety of attentional contexts including 'ignore' conditions, while actively reading a book, while performing other intellectual tasks, or while listening to the unattended ear during dichotic listening (Graham & Hackley, 1991).

In the preceding chapters it has been suggested that MMN is elicited to a deviant stimulus within a steady stream of homogenous "standard" stimuli (Sams, et al., 1985). The nature of attentional processing during the elicitation of MMN was also discussed. Essentially, the early literature has been replete with suggestions that the MMN component of the ERP was strictly preattentive and impervious to the effects of attention, (suggestive of an automatic process over which the subject had minuscule, if any, control) (Näätänen & Gaillard, 1983; Näätänen, et al., 1978; Näätänen, et al., 1980; Sams, et al., 1984; Sams, et al., 1985).

Later studies by Woldorff, et al. (1991) discounted these earlier suggestions of attentional imperviousness. Woldorff, et al., (1991) was able to establish that MMN to an auditory deviant stimuli within a dichotic listening task in two separate experiments was significantly attenuated by a strong auditory, selective attentional, focus by the subject. That is, when the subjects had their attention strongly focused on a secondary task, which placed extensive demands on their processing capacity, the MMN response to deviant stimuli was markedly reduced in amplitude.

Näätänen (1991) responded to the findings of Woldorff, et al., (1991) with an alternative explanation for their findings. Näätänen (1991), while agreeing that some attenuation of the MMN component had occurred in the Woldorff, et al. (1991) study, attributes the majority of the attenuation to attentional effects relative to other components of the ERP rather than to the MMN component. Näätänen (1991) points to other studies where a strong attentional focus was provided where no evidence of MMN attenuation in the unattended channel was exhibited (Alho, Sams, Paavilainen, Reinikainen, & Näätänen, 1989).

Attended and unattended stimuli are thought to influence different components of the ERP. As previously suggested the N2 deflection of the ERP is characteristically divided into two sub-components. According to Näätänen and Gaillard (1983) the MMN/N2a component appears to be involved with the activity of the generator process which reflects the cerebral response to stimulus deviance. The N2b component appears to be task dependent, occurring mainly in attention conditions. As suggested previously the N2b is strongly associated with the P3a component such that in conditions where subjects are asked to ignore the stimulus presented (eg: by reading) no P3a is elicited. In contrast, in attend conditions both the N2b and P3a components will be present (Näätänen & Gaillard, 1983).

Attention Paradigms used in MMN

The study of attentive and preattentive processes within the auditory modality using ERPs has employed two dominant paradigms (Näätänen, 1990). First, the "oddball" paradigm involves the presentation of a homogenous set of repetitive 'standard' stimuli to the subject interspersed randomly with a deviant stimulus at a predetermined level of probability (usually 10%). There are normally two variants of this paradigm; the active mode where the subject actively attends to the deviant stimuli (usually by counting them), and the passive mode, where the subject is passive and is instructed to either ignore the presented stimuli or their attention is deliberately focused upon some other sensory demanding task to distract their attention from the presented deviants (usually a reading task).

Each of these methods is aimed at providing information about the different processing mechanisms mobilized within the brain while interpreting the stimuli. The passive mode explores the involuntary processing of the deviant stimulus whereas the active mode examines the purposeful discrimination of the presented deviants (Näätänen, 1990). A second paradigm, known as the filtering paradigm employs a somewhat different strategy in that deviant stimuli are presented to both ears separately. The subject is required to attend to the stimuli in one ear while ignoring the stimulus presented to the other ear. This task reveals the differential processes involved in both the attended and unattended channels (Näätänen, 1990).

Chapter 4
Introduction IV

Research Aims & Hypotheses

The preceding discussion has provided a brief overview of the current status of the MMN research with a particular emphasis on omission, attention and the relationship that is hypothesised to exist between MMN and the OR (Ford, Roth, & Kopell, 1976; Näätänen, 1990; Näätänen, Gailliard, & Varey, 1981; Sams et al., 1984).

It has been suggested that the MMN generator and the OR mismatch generator have many attributes in common, suggestive of some connection between the two processes (Näätänen, 1990; Näätänen & Gaillard, 1983). Clearly, if MMN and the OR are associated in some way, either as precursors to one another or as component parts of one process, it is crucial to establish if both the OR and MMN react to stimulus omission in a similar manner. On the basis of present evidence, this does not appear to be the case. The incongruity of the findings to date casts some doubt on the veracity of the suggestion that the OR and MMN may be functionally integrated with one another. As previously indicated the relationship of MMN to attention is also particularly uncertain at present.

Research Objectives

The present project aims to establish the effects of stimulus omission during different forms of attentional focus on the elicitation of MMN. Specifically, the methodology involves an "oddball", single-channel selective attention paradigm within the auditory modality. The stimuli presented employed either a stimulus omission as the rare stimulus interspersed within a continuous homogenous stream of standard tones (at a random probability of 10%) or an uninterrupted stream of continuous homogenous standard tones (100% probability).

There were five groups of subjects, three of which received omitted (rare) stimuli (probability 10%) the remaining two groups acted as control groups. The three experimental groups engaged in one of three attentional focus conditions including; first, ignoring the auditory stimuli while reading a book; second, counting the number of omitted stimuli; and finally, passively attending to all the presented stimuli without any additional distraction task. The two control groups engaged in either; ignoring the presented continuous stimuli while reading a text or passively attending to the presented stimuli without any additional distraction task.

Experimental Hypotheses

Both MMN and the OR have been suggested to be preattentive mechanisms which reflect neuronal mismatch generation (Näätänen, 1990). The OR , at least tentatively, has been shown to be responsive to stimulus omission. If MMN and the OR are indeed allied processes it might be expected that MMN should also be elicited to stimulus omission. There have been relatively few studies which have adequately assessed the possibility of a relationship between the OR and MMN in response to omission. Those that have been undertaken have used principally auditory, single attentional focus paradigms and have found little evidence of any MMN waveform in response to stimulus omission. There are some exceptions however in studies using stimulus trains rather than a single deviant stimulus (in which only one component of a train is omitted). MMN is often elicited to these partial omissions.

Given the theoretical importance of being able to establish some link between the neural generators for MMN and the OR it would be of significant interest to establish if MMN can be elicited to stimulus omission under various forms of attentional focus. Since recent research has cast some doubt as to the automaticity and independence of the MMN component of the ERP (Woldorff et al., 1991) it is considered important to include this attentional factor.

The outcome of this experiment will provide insight into the following questions; firstly, can MMN be elicited to omitted stimuli within the auditory oddball paradigm?; secondly, is MMN to the omitted deviant stimuli, within the auditory oddball paradigm, significantly attenuated or elevated by either of the three attention conditions?

Should the outcome of the present research demonstrate the presence of MMN to omission, in any or each of the attentional conditions employed, this would provide tentative support for Näätänen's (1990) suggestion that MMN and the OR may be related preattentive processes and that MMN indexes processes sensitive to change in stimulus input. If however, MMN is not observed to the omitted stimuli this would tend to suggest either that no mismatch was detected or that the mismatch process simply initiates the 'call' for processing rather than processing per se. In addition, any observed differences in MMN due to changes in attentional focus would challenge MMNs status as a wholly preattentive process.

Chapter 5
Method

Subjects

The 50 subjects, who were randomly allocated to one of five groups (resulting in ten (10) subjects per group), were comprised of experimentally naive undergraduate volunteers, participating in the experiment as part of their course requirement. All subjects were aged between 18 and 25 years with a mean age of 18.9 (SD 1.7) years. The ratio of female to male subjects was approximately five to one (42 females and 8 males) with the male subjects spread relatively evenly across conditions. Subjects were screened using a Medical History Questionnaire (Appendix A).

All subjects with a history of excessive alcohol, drug or tobacco consumption, and those who had significant head injury or hearing impairment were excluded from participation. In addition, no subject was permitted to participate if he or she had any first order relatives who were classified as alcoholic (Hill, Steinhauer, & Zubin, 1990; Buffington, Martin, & Becker, 1981). Each subject was required to provide written informed consent (see Appendix B). The project received ethics committee approval from the University of Tasmania Ethics Committee.

Stimuli Employed

The stimuli presented were auditory tones generated by an IBM 386 compatible computer and presented to the subject binaurally through headphones. Standard tones were 50ms in duration (rise time 10ms) at 75 dB intensity. In each of the conditions presented the subjects were exposed to the same intensity of stimulus with the exception being that in some conditions the stimulus was continuous (standard) while in others stimulus omissions (rare) occurred. All omitted tones occurred in random order and all standard tones were characterised by an interstimulus interval (ISI) of 1000ms (onset to onset). A minimum of five standard tones preceded any omitted tone (Robinson, 1991).

Electroencephalographs (EEG)

The electroencephalographic (EEG) record of each subject was obtained using a Grass Neurodata Acquisition System (Model 12) integrated with an IBM compatible 386 computer. Electrodes were connected to each subject in accordance with the International 10/20 placement system (Jasper, 1958) using a skull cap fitted with tin electrodes. Measurements were recorded from each of three sites including Fz, Cz, and Pz. The right ear lobe served as a reference for the EEG.

The EEG and computer equipment were configured to provide sampling at 500 Hz. The amplifiers had a high frequency cut off at 30 Hz and a time constant of 15sec. Vertical EOGs were recorded (since the midline sites were of predominant interest) (Gratton, Coles, & Donchin, 1983) using tin electrodes fitted above and below the subjects right eye. EEG epoch averaging and EOG recording were performed by the IBM compatible 386 computer for a period of 660ms commencing 60ms before stimulus presentation. Electrode impedances were strictly controlled below 5kΩ. All EEG records with an EOG artefact exceeding 70μV were eliminated online from the computed averages to prevent contamination of EEG records (Sams et al., 1984).

Design

A 5 x 3 x 3 factorial design was employed in the experiment. The between-subjects factor was *Condition* (5) and the within-subjects factors included *Tone* (3) (pre, rare, post); and *Electrode Site* (3) (Fz, Cz, Pz). The dependent variable was the mean amplitude of MMN for various intervals. The independent variables were Condition (5), Tone (3), and Site (3). Subjects were randomly assigned to one of five attending groups;

Group A **- Reading (ignore) Condition**

(10% Omitted (rare) & 90% Standard Tones - Subjects ignored tones and actively read a book during stimulus presentation).

Group B **- Reading (ignore) Control Condition**

(All Standard tones - Subject ignored tones and actively read a book).

Group C **- Counting Condition**

(10% Omitted (rare) & 90% Standard - subject kept a running count of the number of omitted (rare) tones).

Group D **- Passive Attending Condition**

(10% Omitted (rare) & 90% Standard - subject listened to the tones but ignored the omitted tones).

Group E **- Control Passive Attending Condition**

(All standard Tones - subject attended to tone).

EEG was recorded and averaged for first; *pre* measures of the subjects response to the tone immediately preceding a rare stimulus, second; *rare* measurement (where an omission of a tone occurred within the series of standard tones) and finally, *post* measurement (of the response to the tone following immediately after a rare stimulus). In the two control conditions where the stimuli were continuous pre, rare, and post stimuli were randomly selected to conform to the same criteria as applicable to the experimental conditions.

Procedure

The subjects were first fitted with the requisite EEG electrodes following the 10/20 International placement system (Jasper, 1958). Subjects in this experiment were then required to sit in a sound attenuated room to eliminate extraneous stimuli. The equipment controlling the stimulus presentation was located in an adjoining room. Subjects were seated comfortably in an upright chair facing an opaque screen.

Subjects were given explicit instructions regarding their role in the experiment and were cautioned to try to remain alert throughout the experiment. The form of instructions varied depending on group membership. Condition A and B groups were asked to read a book and to ignore the auditory stimuli. Condition C group was required to attend to the auditory stimuli while counting the number of omitted tones. Condition D and E groups were asked to simply attend to the tones. Table 1 provides a summary of the stimulus attributes and direction of attention for each of the five groups.

The stimuli were presented to the subjects binaurally via headphones in six (6) blocks of trials with 500 tones per block. The duration of each block was exactly 8 minutes followed by a short intermission of approximately 30 seconds duration (subjects were instructed not to count the intermissions between blocks as omissions). In each of the conditions the subject was required to maintain his/her concentration on his/her assigned task and to keep their vertical eye movements and blinking to a minimum.

At the conclusion of the experiment subjects were debriefed and those subjects in the counting condition were asked to indicate the number of omitted tones observed. Those subjects in the reading conditions completed a short comprehension questionnaire (Appendix C) on the material read (all subjects in the reading conditions were required to read the same material).

Data Analyses

The data were analysed using both a CSS statistical package on an IBM compatible 486 computer and SuperAnova on a Macintosh IIci. The initial analysis involved 5 (Groups: A - E) x 3 (Sites: Fz, Cz, Pz) x 3 (Tone: pre, rare, post) x 8 (Interval: 2-9) ANOVA on the complete data.

Table 1 : Shows the stimuli presented to each of the five groups along with direction of attention and the applicable subject instructions.

GROUP	DIRECTION OF ATTENTION	STIMULI
A	***Reading (ignore) Condition*** (Omitted tones occurred in the sequence of standard tones. Subject was instructed to read a book and ignore the presented tones as much as possible. Subject was informed of post session comprehension test)	**tttt ttttt tttt** → Time • 10% Omitted • 90% Standard • Random Omissions
B	***Reading (ignore) Control Condition*** (Standard Tones are presented continuously. Subject was instructed to read a book and ignore the presented tones as much as possible. Subject was informed of post session comprehension test)	**tttttttttttttt** → Time • Standard Tones presented 50 ms duration.
C	***Counting Condition*** (Omitted tones occur in the sequence of standard tones. Subject was instructed to attend to the tones & to count the number of omitted ones. Subject was informed that a post session total of the omitted tones will be required.)	**tttt ttttt tttt** → Time • 10% Omitted • 90% Standard • Random Omissions
D	***Passive Attention Condition*** (Omitted tones occur in the sequence of tones. Subject was instructed to, as far as possible, simply attend to the tones.)	**tttt ttttt tttt** → Time • 10% Omitted • 90% Standard • Random Omissions
E	***Passive Attention Control Condition*** (Standard tones are presented continuously. Subject was instructed to, as far as possible, simply attend to the tones.)	**tttttttttttttt** → Time • Standard Tones presented 50 ms duration.

The between subjects factor was Group (5) and the within subjects factors were Site, Tone and Interval. The dependent variable was mean amplitude of ERP recording for each of the pre, rare and post stimulus epochs. The 12 intervals of measurement (of which only intervals 2-9 were included in the analyses) involved the following time frames; 1 (0-50ms), 2 (50-100ms), 3 (100-150ms), 4 (150-200ms), 5 (200-250ms), 6 (250-300ms), 7 (300-350ms), 8 (350-400ms), 9 (400-450ms), 10 (450-500ms), 11 (500-550ms), 12 (550-600ms).

Subsequently, as significant 4-way interactions were revealed by the ANOVA, discreet two-way ANOVAs at various intervals and Fisher LSD post-hoc tests were undertaken. Significance criterion was set at the .05 level for both ANOVAs and Fisher LSD analyses. Greenhouse-Geisser corrections for repeated measures were used in the Anova analyses. Copies of both the raw data and the analyses undertaken may be found in Appendix D and E respectively.

Chapter 6
Results

A four-way Anova (Group (5) x Site (3) x Tone (3) x Interval (8)) was completed on the mean amplitudes which indicated that the main effect of Group was non-significant ($F(4,45) = .91792$, $MSe = 75.304$) and that the four-way interaction was significant ($F(112,1260) = 6.868$, $MSe = 0.266$) (see Appendix E1 for additional results of analyses). To facilitate comprehension, subsequent further analyses were therefore carried out separately for pre, rare and post stimuli at various intervals.

Two-way Anovas (Group x Site) were completed on the pre responses for each of intervals 2 - 9 (from 50ms to 450ms). The main effect of Group in the pre responses was not significant for any interval. Table 2 shows the Group results of the 2 way Anova analyses for each interval of the pre responses. This suggests that the individual conditions for each group had no effect on the subjects "pre" response to standard tones.

Grand-Mean Averages

The raw amplitude data for each group (reflecting the measurement of each of the subjects responses to the pre, rare and post stimuli at Fz, Cz and Pz) were collated and grand-mean average ERPs were computed for each of the five groups for each stimuli at each site.

Table 2 Shows the group results of the two way Anova analyses for each interval of the pre responses.

Interval	*F value*	*df*	*MSe*
2	.559	4,45	9.27
3	1.341	4,45	7.87
4	0.736	4,45	9.02
5	1.187	4,45	7.41
6	0.054	4,45	7.84
7	0.249	4,45	7.19
8	0.614	4,45	6.08
9	0.358	4,45	6.08

Figure 1 shows the grand-mean average ERP waveforms elicited in response to pre, rare and post stimuli. These have been superimposed on one another to permit a clearer comparison of the pre, rare and post waveforms for each of the five groups (A: Reading (Ignore) Omission, B: Reading (Ignore)-Control, C: Counting Omission, D: Passive Attend-Omission and E: Passive Attend-Control) at each of the three (3) measured sites (Fz, Cz and Pz).

It can be seen in Figure 1 that no substantial differences were exhibited between the pre, rare, and post responses for either of the two control groups (Group B - Reading Control Group; Group E - Passive-Attend Control Group). There were however clear differences in negative amplitude between the three sites at around 200-400 ms. The frontal sites in both control groups for pre, rare and post stimuli appear to have produced the larger negative N2 amplitudes. Cz amplitudes were very similar to those for Fz whereas Pz sites appeared to be substantially lower in amplitude. Similarly, amplitudes were larger in the Passive Attend Control Group than in the Reading Control Group suggesting some effect of attention on the ERPs in the control conditions.

The graphs in Figure 1 suggest that there was no MMN elicited to the rare (omitted) stimuli in any of the three (3) experimental groups. In each of the experimental groups (Groups: A, C and D) a characteristic N1 and P2 wave was evident in the pre and post responses. The magnitude of N1 and P2 was larger in all the experimental groups than in the control groups for the post stimuli suggesting an increased refractory period (the increased response resulting from the slower recovery of the organism) to the tone immediately following an omitted tone (Martin et al., 1992). N1 or P2 were not evident for the rare responses suggesting very little early activity to omitted stimuli.

At around 150ms there was some negative activity maximal at Fz to the omitted stimuli in both the Counting and Passive-Attention Groups which may indicate some form of MMN (although these were of very small amplitude). This was not evident in Group A where subjects did not attend to the stimuli. It is difficult to determine if the negativities observed in the counting and passive attention groups represent MMN or the N2b negativity component. Since the negativities are accompanied by

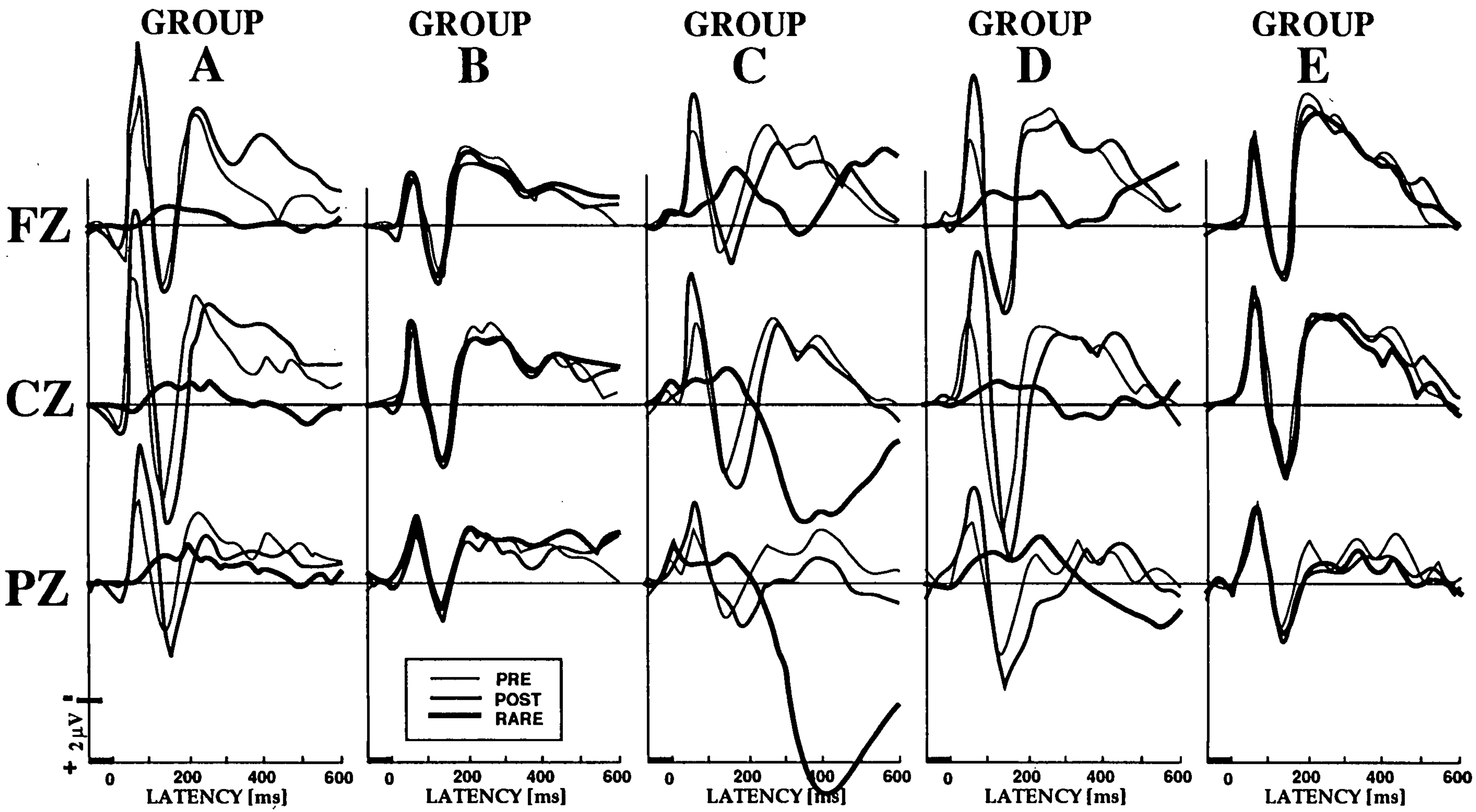

Figure 1 Shows the Grand Mean Average ERPS elicited by the Pre, Rare and Post stimuli for each of the five groups at the Fz, Cz and Pz sites. Group A - Reading [Ignore]; Group B - Reading [Ignore] Control; Group C - Counting; Group D - Passive Attention; Group E - Passive Attention Control.

the P300 component in these two groups it is more likely that they represent the N2b/P3a complex rather than a MMN/N2a component. If MMN is present in these negativities it is likely to be embedded within the N2b responses.

In contrast to the pre responses there was a marked negativity of post responses in Group A at both Fz and Cz sites. This negativity had an onset latency at Fz of around 200ms reaching peak amplitude at between 250 - 330ms. The Cz site had a slightly lower amplitude and a somewhat less prominent peak but occurred at around the same latency. The Pz site however displayed no evidence of this negative going waveform in either the pre or post measures. This late negative activity to the post tones was not evident in any other group.

At 400ms there was positive activity maximal at Pz in the Counting Group C and some evidence of positive activity in the Passive Attention Group D. This activity represents a P300 induced by counting the omitted stimuli.

Inferential Analyses

Refractory Period

Two-way Anovas (5 (Group) x 3 (Site)) were completed on the post stimuli at intervals 2 (50-100 ms), and 4 (150-200 ms), where maximal activity related to the refractory period was observed. Figure 2 shows the mean amplitudes for post intervals 2 and 4 for all conditions at Fz, Cz and Pz.

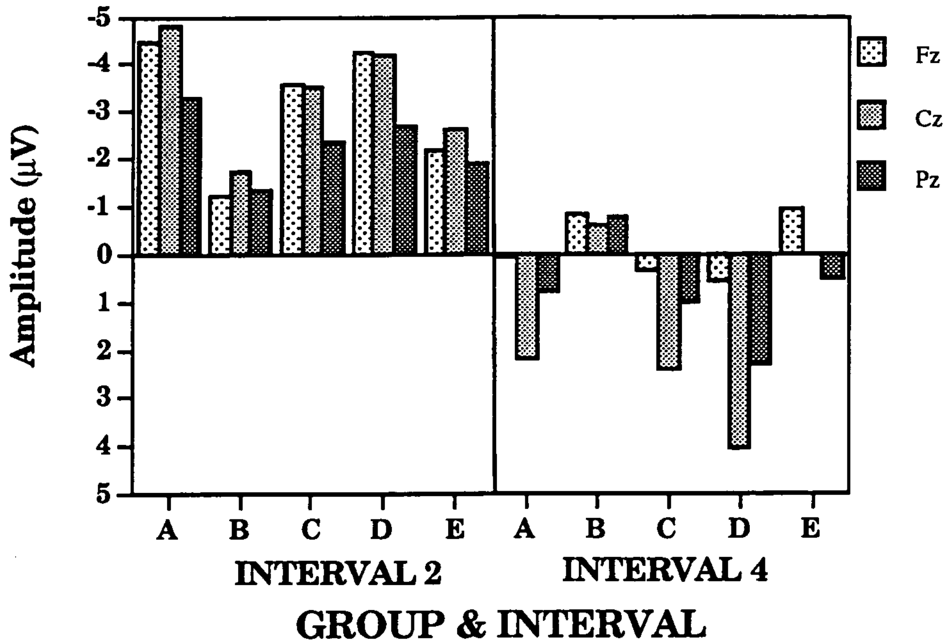

Figure 2 Mean amplitudes for Post Intervals 2 (50-100ms) and 4 (150-200ms) for all conditions and all sites. (A: Reading [ignore]; B: Reading [Ignore] Control; C: Counting; D: Passive Attention; E: Passive Attention Control).

At interval 2 there was a significant main effect of Site (F(2,90) = 17.374, MSe = 0.877) where Fisher LSDs showed Fz significantly more negative than Pz and Cz significantly more negative than Pz.

There was also a significant main effect for Group (F(4,45) = 2.974, MSe = 12.49). Fisher LSDs showed Group A to be more negative than either Group B or Group E. This reflects a larger refractory period in Group A than in either of the Control Groups (B and E). Group D was more negative than Group B again reflecting the larger refractory period on this early section of the ERP. The interaction was not significant (F(8,90) = 1.628, MSe = 0.877).

At interval 4 there was a significant main effect for Site (F(2,90) = 29.484, MSe = 1.330) and Group (F(4, 45) = 3.468, MSe = 12.46) and a significant interaction between Group and Site (F(8,90) = 3.686, MSe = 1.330).

For the Site main effect Fisher LSDs showed Cz to be significantly more positive than either Fz or Pz and also Pz to be significantly more positive than Fz. The Fisher LSD tests for group showed that Group D responses were more positive than either Groups B or E and that Group C was more positive than Group B. These findings once again point to the greater refractory period for the attending experimental groups at the early section of the ERP.

The Fisher LSD tests for the Interaction of Group and Site show that there were, with one exception (Group E - between Fz and Pz), no significant differences across site for either of the Control Groups (B and E). The analyses also revealed that positivity was maximal at Cz sites for each of the three experimental groups (A, C, and D) and that Group D was significantly more positive when compared to Groups A and C at least at Cz and Pz.

Fisher LSDs showed that the experimental groups (A, C, and D) were significantly more positive than the control groups (B and E) at Cz. This was also true at Pz with two exceptions (Groups A and C were not significantly different from Group E). At Fz both Groups D and C were significantly more positive than Groups B and E. In summary, the interaction post-hocs for Interval 4 show that Cz sites exhibited maximal amplitude suggestive of a refractory period. All three experimental groups (A, C and D) exhibited the refractory period in contrast to the two control groups (B and E).

Mismatch Negativity

Two-way Anovas (5 (Group) x 3 (Site)) were undertaken for intervals 3 (100-150 ms) and 4 (150-200 ms) on the rare stimuli to investigate the effects of each of the experimental manipulations on the elicitation of MMN. MMN has been shown to occur from 100-200ms (Näätänen, 1986a). Figure 3 shows the mean amplitudes for intervals 3 and 4 for rare tones for all conditions at Fz, Cz and Pz.

At Interval 3 there was a significant main effect of Site ($F(2,90) = 4.703$, $MSe = 0.438$) where Fisher LSD tests showed both Pz and Fz to be significantly more negative than Cz. There were no other significant differences between sites.

There was also a significant main effect for Group ($F(4,45) = 7.729$, $MSe = 2.296$) at interval 3. Fisher LSDs showed that Groups A, C, and D were all more negative than either of Control Groups B and E. This indicates that all three experimental Groups (A, C and D) exhibited a negative trend towards MMN not exhibited by the control groups. However, as can be seen in Figure 3 Group A maximum negativity occurred at Pz which is contrary to normal expectations for MMN since it is generally observed to be maximal at Fz (Näätänen, 1990; Näätänen & Gaillard, 1983).

Groups C and D exhibited negativity maximal at Fz. The interaction was not significant (F(8,90) = 1.814, MSe = 0.438).

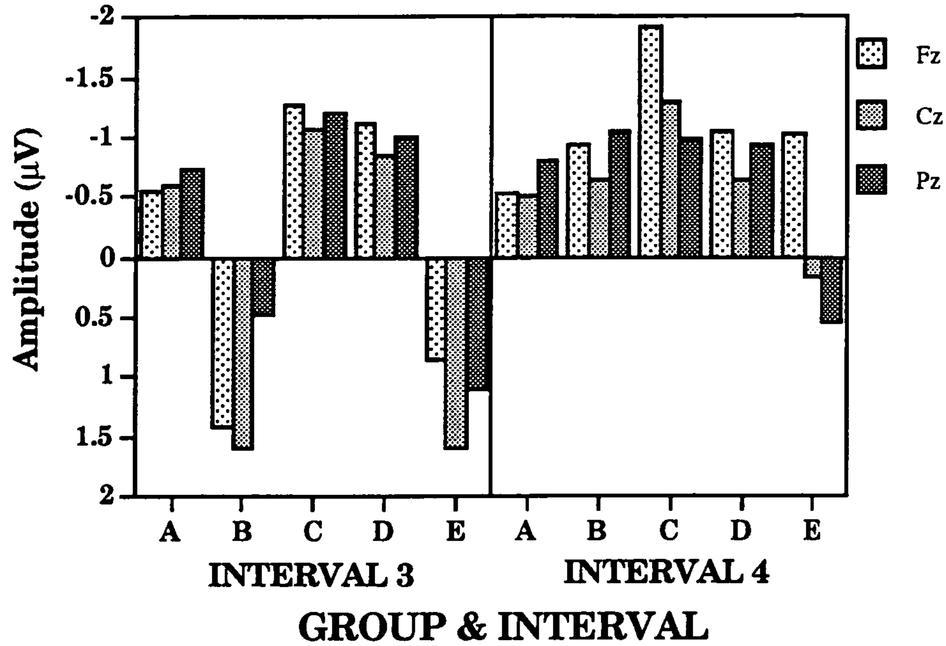

Figure 3 Mean amplitudes for rare Intervals 3 (100-150ms) and 4 (150-200ms) for all conditions and all sites (A: Reading [ignore]; B: Reading [Ignore] Control; C: Counting; D: Passive Attention; E: Passive Attention Control).

At interval 4 there was a significant main effect for Site (F(2,90) = 6.535, MSe = 0.576) but the main effect for Group was not significant (F(4,45) = 0.942, MSe = 7.033). There was however a significant interaction between Group and Site (F(8,90) = 2.692, MSe = 0.576).

For the Site main effect Fisher LSDs showed Fz more negative than Cz and Pz. There was no significant difference between Cz and Pz.

The Fisher LSD tests for the Interaction of Group and Site showed that there were no significant differences between sites for Control Group B. Control Group E however exhibited significant differences between Fz and both Cz and Pz. It was apparent that Fz was significantly more negative than Cz and Pz in Control Group E. This also may be an effect of attention. However, maximal negativity was found at Fz for Group C which was significantly more negative than either Group A or Group D.

There were no significant differences between the experimental groups (A and D) and either of the Control Groups (B, E) at Fz, however, Group C was significantly more negative than either of the Control Groups B and E. This was also true of Cz with the exception that both Group C and D were significantly was more negative than Group E. At Pz all the Experimental Groups (A, C, D) were significantly more negative than Control Group E. In summary, the findings of the interaction post-hoc tests indicate that there is some evidence of MMN at Fz at this interval (4) in experimental Group C compared to Control Groups B and E. Responses for Group A at all sites were smaller than for any other condition with the exception of Group E (Cz and Pz).

Dishabituation

Two-way Anovas (5 (Group) x 3 (Site)) were used to assess Intervals 5, 6 and 7 on the post stimuli to investigate the effects of dishabituation following the experimental manipulations. Figure 4 shows the mean amplitudes for post intervals 5, 6, and 7 for all conditions at Fz, Cz, and Pz

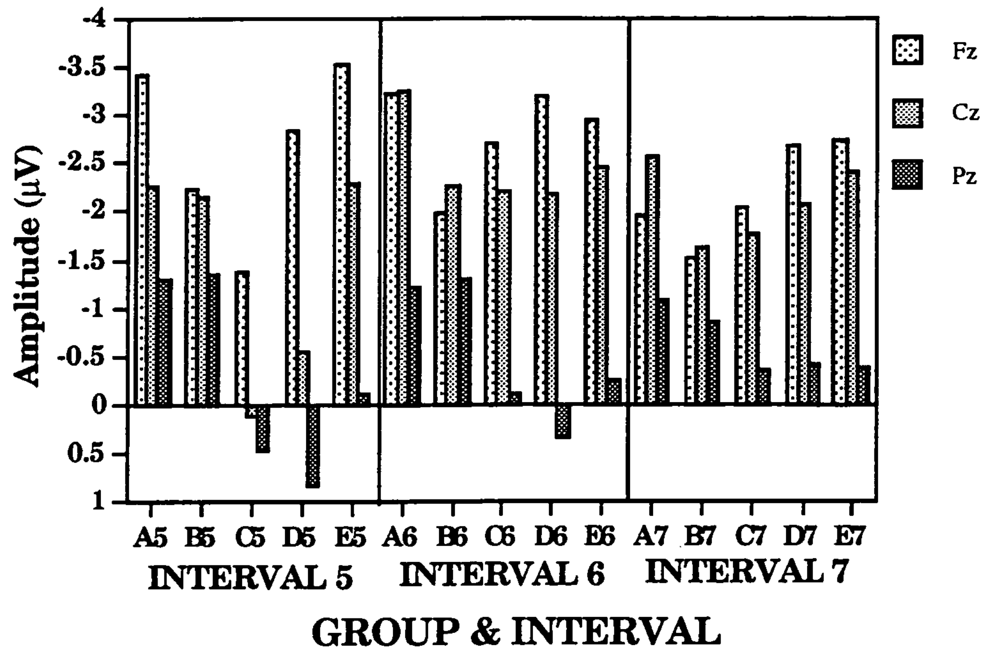

Figure 4 Mean amplitudes for post stimuli at Intervals 5 (200-250ms), 6 (250-300 ms) and 7 (300-350 ms) for all conditions at all sites.
(A: Reading [ignore]; B: Reading [Ignore] Control; C: Counting; D: Passive Attention; E: Passive Attention).

At Interval 5 there was a significant main effect of Site (F(2,90) = 84.994, MSe = 0.832). There was no significant group effect evident (F(4,45) = 1.626, MSe = 13.976). There was however a significant Group x Site interaction present (F(8,90) = 4.899, MSe = 0.832).

Fisher LSD tests for Site revealed that Fz was significantly more negative than either Cz or Pz. In addition, Cz was more negative than Pz. That is the frontal sites were more negative than either the central of parietal sites.

Post-hoc analyses (Fisher LSDs) for the interaction of Group and Site at interval 5 show that for Control Group B there were only significant differences across site between Fz and Pz (with Fz being more negative than Pz). This contrasted with Control Group E which exhibited significant differences between all sites (Fz being more negative than either Cz or Pz). This once again reflects attentional influence. At Fz Group A and Group E were significantly more negative than Group B and Group C suggesting that dishabituation only occurred for Group A compared to Group B. Thus, dishabituation was only exhibited in the non attending omission condition at Fz. As can be seen in Figure 4, at both Cz and Pz there was no evidence of dishabituation following omission in the unattended stimuli (Group A) at this interval.

At interval 6 there was a significant main effect for Site ($F(2,90) = 76.967$, $MSe = 1.007$) where Fisher LSDs showed Fz and Cz to be significantly more negative than Pz. There was no significant group effect present at this interval ($F(4,45) = 0.386$, $MSe = 10.239$) but the interaction between Group and Site was significant ($F(8,90) = 2.839$, $MSe = 1.007$).

The post-hoc analyses (Fisher LSDs) of the interaction revealed that at Fz and Cz Group A was significantly more negative than Group B again suggesting dishabituation in the unattended condition (A) at Fz and Cz at this interval. There were no significant differences across site evident in Control Group B with the exception that Cz was significantly more negative than Pz. Once again this contrasted with Control Group E which exhibited significant differences between Pz and both Fz and Cz.

At interval 7 there was a significant main effect for Site (F(2,90) = 54.784, MSe = .703) Fisher LSDs showed Fz and Cz, which did not differ, to be more negative than Pz. The main effect of Group (F(4,45) = 0.255, MSe = 7.382) was not significant. However, there was a significant interaction between Group and Site (F(8,90) = 2.349, MSe = 0.703).

The post-hoc analyses of the interaction between Site and Group for interval 7 revealed that at Cz Group A was significantly more negative than Group B. At Fz only the Passive attention Group D were significantly different from the Control Group B. There were significant differences in response across Site for Control Group B where Cz was more negative than Pz in contrast to Control E which showed Fz and Cz significantly more negative when compared with Pz. In summary the interaction analyses for post responses at intervals 5, 6, and 7 indicate a significant dishabituation effect was present in Experimental Group A when compared with Control Group B predominantly at the Fz and Cz sites. By interval 7 these affects had diminished below the level of significance at the Fz site.

P300 Component

Two-way Anovas (5(Group) x 3 (Site)) were undertaken for intervals 6-9 (6: 250-300 ms; 7: 300-350 ms; 8: 350-400 ms; 9: 400-450 ms) on the rare stimuli to investigate the effects of the omitted stimuli on the elicitation of the P300 component of the

ERP waveform. Figure 5 shows the mean amplitudes for rare intervals 6-9 for all conditions at Fz, Cz, and Pz.

There were significant main effects for Site at all the intervals analysed: interval 6: ($F(2,90) = 15.919$, MSe = 1.013); interval 7: ($F(2,90) = 15.882$, MSe = 1.155); interval 8: ($F(2,90) = 23.585$, MSe = 1.243), interval 9: ($F(2,90) = 28.700$, MSe = 1.389). In each case subsequent Fisher LSD post-hoc analyses showed that Cz and Pz were significantly most positive than Fz. At intervals 6, 7, and 8 there were no significant differences between Cz and Pz. However at interval 9 Pz was significantly more positive than both Cz and Fz.

There were also significant main effects for Group at all the intervals analysed: interval 6: ($F(4,45) = 3.512$, MSe = 12.207); interval 7: ($F(4,45) = 9.017$, MSe = 11.722); interval 8: ($F(4,45) = 7.133$, MSe = 13.720); interval 9: ($F(4,45) = 6.321$, MSe = 13.970). In each case subsequent Fisher LSD post-hoc analyses suggested that Group C, the Counting Group, was significantly more positive than either of the control groups. This finding reflects the presence of the P300 waveform in response to the subject counting the presented omissions in the attending condition.

There were also significant interactions between Group and Site at each of the intervals analysed: interval 6: ($F(8,90) = 8.205$, MSe = 1.014); interval 7: ($F(8,90) = 10.101$, MSe = 1.155); interval 8: ($F(8,90) = 12.913$, MSe = 1.243); interval 9: ($F(8,90) = 14.903$, MSe = 1.389). Subsequent Fisher LSD tests showed that at Interval 6, at both Cz and Pz, Counting Group C was more

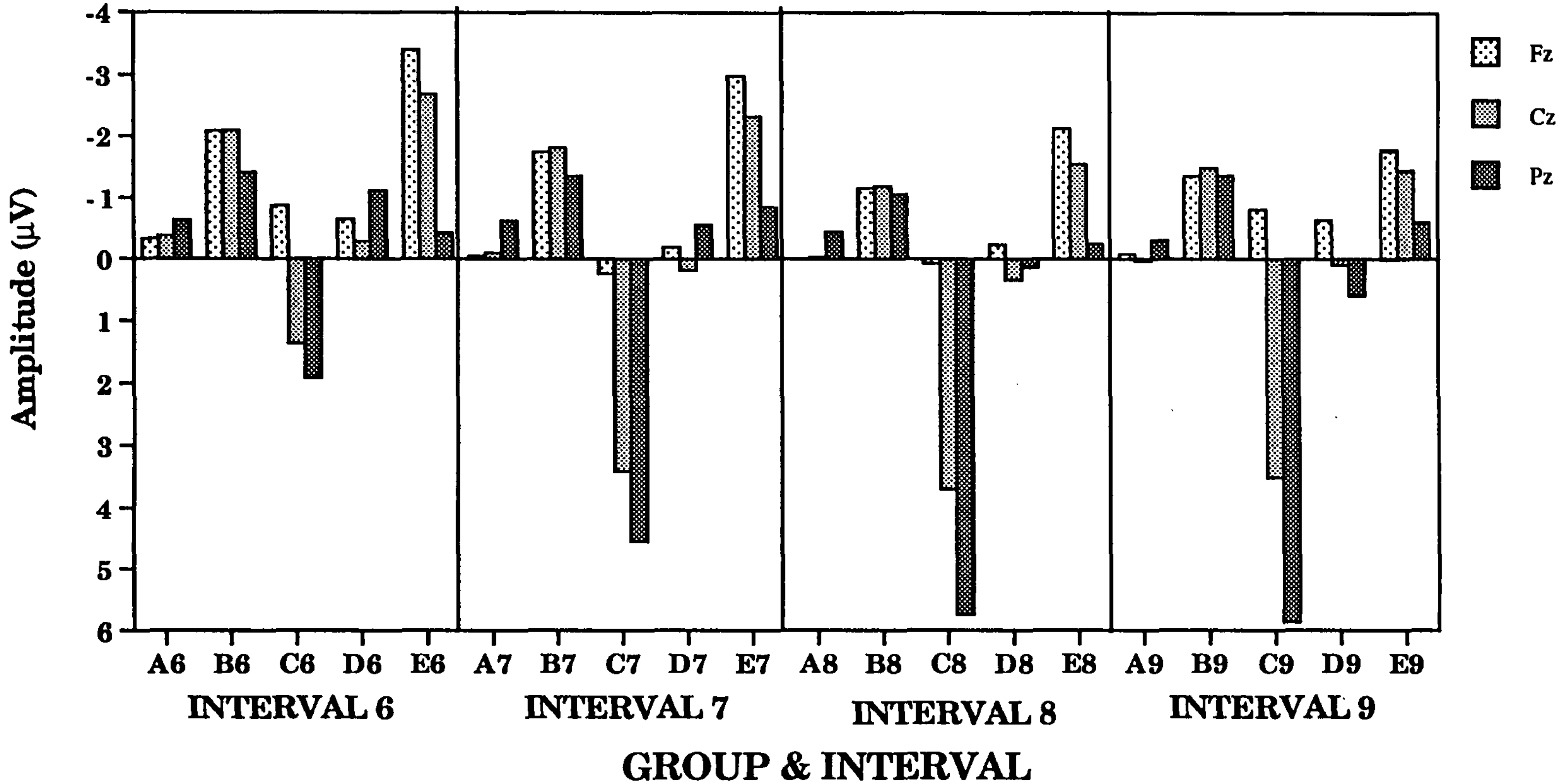

Figure 5 Mean amplitude for Rare stimuli at Intervals 6 (250-300), 7 (300-350 msec), 8 (350-400 msec), 9 (400-450 msec) for all conditions at all sites. (A: Reading [ignore]; Reading [Ignore] Control; C: Counting; D: Passive Attention; E: Passive Attention Control).

positive than either Groups A, D or either control group suggesting the beginning of a P300 waveform at Cz and Pz to the counting condition.

At intervals 7, 8, and 9 Fisher LSDs showed that Group C was significantly more positive than any other group at Cz and Pz (i.e.;. P300). Group D was significantly more positive than Group B at intervals 8 and 9 at Cz and Pz. At Cz and Pz Group D was more positive than Group E. These results indicate a strong P300 effect in the counting condition and a weak P300 in the passive attending condition Group D which was maximal at Pz.

Comprehension Test and Omission Counting Results

The Reading (Ignore) Group A and the Reading (Control) Group B were required to complete a brief comprehension test on the material read. The Counting Group C were required to count the number of omitted stimuli. These responses were then analysed. The reading comprehension test was scored by calculating the percentage of correct answers based on the total number of questions attempted.

The mean percentage of correct answers for subjects in Group A was 93.33% while Group B achieved 86.67 %. A between-groups Anova showed that there were no significant differences in comprehension between the two groups ($F(1,18) = 1.800$, $p =$

.1964). This suggests a high degree of attentional focus and that the reading conditions were comparable.

In the counting task the subjects accuracy was based on their estimate of the number of omitted stimuli relative to the actual number of omissions (300). The mean percentage accuracy of omitted stimuli counted by the subjects in Group C was 97.27%. This result supports the suggestion that subjects in Group C closely attended to the omitted stimuli in the counting condition.

Chapter 7
Discussion

The purpose of the present study was to establish if MMN could be elicited by stimulus omission, under various forms of attentional focus. The outcome of this research was then expected to permit some evaluation of the degree of correspondence between MMN and the OR in response to stimulus omission.

Overall, with the exception of the Counting Group C, the results of the experiment demonstrated a predominantly fronto-central response distribution in line with previous findings for auditory responses. Group C exhibited more parietal responses.

The results obtained were largely in agreement with the experimental hypothesis - that there would be little evidence of an unequivocal MMN response to omission in the rare responses of any of the experimental groups (although, as the results suggest, this observation might be somewhat debatable). These findings provide little evidence of any correspondence between the OR and MMN specifically in relation to their response attributes to stimulus omission.

The results clearly demonstrated that both Control Groups (B and E) exhibited consistent response patterns irrespective of pre, post and rare stimulus measurement. Although, responses in Group E were larger than those observed in Group B suggesting that the difference in attentional focus between them may have contributed to the differential response patterns. Other than this the experimental conditions appeared to have had little impact on the response of subjects to standard tones in the control conditions.

There was an absence of any significant evidence of a MMN response to the rare omissions. In qualification of this assertion, it should be pointed out that there was some evidence of significant negativity at intervals 3 (100-150ms) and 4 (150-200ms) in the responses of the experimental Groups (A, C, and D) when compared to the Control Groups B and/or E. There was also some evidence of frontal negativity in both the Counting Group C and Passive Attention Group D, maximal at the 200 ms latency. However, these observed negativities, although suggestive of a MMN effect, were construed as reflecting an absence of activity rather than a specific response to the omitted stimuli.

Examination of the waveforms relevant to the latter findings indicated an absence of the typical ERP waveform, (including the N1/P2 components). Since the N1 component is suggested to be involved in an "attention switching" response to the initial presence of a physical stimulus the latter observation supports the assumption that little activity was present rather than that a MMN response had occurred. These findings replicate many of the effects observed by Robinson (1991) and Martin et al., (1992) in experiments with a similar auditory omission paradigm.

A significant dishabituation effect was present in the post responses, primarily in the Reading (ignore stimuli) Group A at the Fz site (when compared to Control Group B). The effects occurred mainly at intervals 5 and 6 and tended to be reduced considerably by interval 7. Dishabituation was also present at Intervals 6 and 7 at Cz for Group A, but to a lesser extent. This latter observation also proved to be significant. Thus it would appear that dishabituation occurred only in the non-attending condition at predominantly fronto-central sites. That is, attention to the deviant stimuli removes dishabituation.

In addition to these findings there was evidence of a significant **P300** to the omitted stimuli in the Counting Group (C) at predominantly centro-parietal sites. A weak P300 was also found in the Passive Attention Group. A P300 appears to have occurred only in the conditions in which the subject attended to the omitted stimuli. The P300 appeared to be much stronger when the subjects were actively attending. There was some evidence of the N2b negativity component which is suggested to be closely associated with the P300 component. The N2b/P3a complex is typically thought to be elicited when subjects attend to deviant stimuli.

There were also significant **refractory** effects for all experimental Groups (A, C, D) in the post responses, at the Cz and Pz sites (with the exception of Group A when compared to Group E), to those standard stimuli immediately following the omitted tone. These responses were characterised by an elevation in both negative and positive amplitude in the post response measurement epochs. At Fz significant differences were evident in the responses of both the Counting Group C and the Passive Attention Group D when these were compared with the two control Groups (B and E). The refractory effects were maximal at centro-parietal sites and were characterised by an elevated N1/P1 response amplitude to the post tones. Groups A and D refractory periods were similar while Group C refractory amplitude was considerably reduced in comparison. This elevated refractory period in the post responses was considered to be attributable to the length of the ISI (effectively 2 Seconds) and is replicative of previous research by Martin et al. (1992).

Implications of Findings

The finding of little evidence of a MMN to omitted stimuli is entirely in agreement with the previous findings of Martin et al. (1992) and Robinson (1991) who demonstrated that MMN was not elicited to omitted auditory stimuli (these studies utilised a similar reading (ignore) condition to the one employed within the present research).

These MMN to omission findings contrast with recent research by Tervaniemi et al. (1993) suggesting that MMN was elicited both when the order of presented tones were reversed or when the second stimulus of a stimulus pair was omitted. However, the effects may have been observed in this case because of the nature of the stimulus omission employed. The researchers employed a *"tone pair"* formed by two closely paced tones of different frequencies. They then either reversed the order of the tones or omitted the second tone of the pair.

The fact that both of these manipulations elicited MMN suggests that the partial omission condition employed by them was fundamentally different to the complete omission condition applied in the present experiment. Therefore, it is difficult to extrapolate any satisfactory explanation for the incongruity between these findings other than to suggest that the omissions were fundamentally different from one another.

The differences between full omission and partial omission processing were discussed by Siddle (1985) predominantly in relation to the OR. Siddle's (1985) suggestion was that, when one component of a paired stimulus is omitted, some information still exists to act as a specific retrieval cue. However, in the case of complete omission contextual cues become paramount and the processing demands are therefore increased.

If the latter suggestion is correct then it has important implications for the integration hypothesis regarding MMN and the OR. It raises the possibility of both quantitatively and qualitatively different levels of contextual processing between the OR and MMN generators. That is, it may be the case that the MMN neural generator is somehow restricted to a narrow time window for stimulus processing while the OR generator has much broader parameters (being multimodal and able to process a wider array of not only specific stimulus attributes but also substantial contextual information in relation to the presented stimuli).

Of course the latter rationale is merely conjecture. The existence of such differences needs to be tested empirically through additional research. It may be the case that increasing the duration of the rare omitted stimulus might enable the effects of contextual information to be incorporated within the neural representation of the MMN generator. Since the neural generator would have more time to integrate the contextual information relative to the omitted stimuli a mismatch may thus be enabled. Future research, employing variable duration omissions, may be able to establish an optimal point at which sufficient contextual information can be integrated in the neuronal store to permit MMN to be elicited.

Although Sokolov's (1963a) model comparator process for the OR bears a striking resemblance to the MMN comparator process (according to Näätänen (1986b)), (which would predict the elicitation of MMN to omission), the outcome of the present MMN research does not support this model. Thus, Näätänen's (1990) proposal that MMN and the OR are likely to be closely allied processes is not supported at least as far as stimulus omission is concerned. This raises doubts about the functional relationship between the OR and MMN comparators and the adequacy of Sokolov (1963a) comparator model for the OR.

The foregoing discussion has provided suggestions regarding the possible importance of contextual cues in the establishment of an omission neural representation. It has been suggested that a neural representation of the deviant stimuli is maintained in the neuronal store as a neural trace (Näätänen, 1982; Näätänen, 1988). This trace is then used in a comparator process to establish a match between the representation of the standard tone trace and the deviant.

According to Näätänen and Lyytinen (1989) for MMN to be elicited all physical features of the deviant auditory stimulus would have been fully processed. However, given the rapidity of the establishment of the neuronal trace it is difficult to see how a trace of an omitted stimulus can be adequately developed since processing the omission requires laying down of the 'context' (as suggested by Siddle (1985) in relation to the OR) within which the omission occurred and not just the characteristics of the stimulus as is the case with a physical deviant stimulus.

What is being suggested here is that the processing demands required of the neural comparator in processing an omission are infinitely more complex than that involved in processing physical stimulus deviance. This is probably true for both MMN and the OR but appears to be particularly crucial in the case of MMN since the mechanism of processing appears to preclude a sufficient evaluation of the contextual aspects of omitted stimuli. It is possible that this is due to either limitations in the processing capacity of the MMN neuronal store or to the stimulus specificity of specific cell populations.

Graham and Hackley (1991) have suggested that some stimuli may be difficult to encode and may require qualitatively different processing. As there are no characteristics on which to base the stored representation of the stimulus such as pitch, tone, frequency etc, the comparator mechanism must scan for any distinctive attributes relative to the omission on which to base a representation. It is suggested that this process may demand additional time to accomplish and consequently MMN is not possible since the comparator does not have time to establish a sufficiently elaborate neural representation and it may also lead to dishabituation. This explanation might account for the observations of Tervaniemi et al. (1993) who observed MMN to omission in response to the omission of one component of a stimulus pair as suggested by (Tervaniemi et al., 1993).

The findings regarding the refractory period suggest that the stimulus omissions following the repetitive standard stimulus presentations induces an elevated re-establishment of the response to the standard stimuli. This clearly demonstrates that some sensitization to the standard stimuli occurs as the result of frequent repetition and that a recovery occurs when standard stimulus presentation is interrupted. As previously suggested the elevated refractory period in the post responses was considered to be attributable to the length of the ISI (effectively 2 Seconds). These refractory responses were most evident at the 100 ms latency and were associated with the N1 component of the ERP which is suggested to index initial physical registration of the presented stimuli (Näätänen & Gaillard, 1983).

The dishabituation results seen in the Reading (Ignore) Group A indicate that the subjects in this condition were more likely to habituate to the standard stimuli in the pre trials and to exhibit dishabituation in the post trials (to the stimuli immediately following the deviant omitted presentation). Therefore, it would appear that unattended stimuli result in an increased likelihood for subjects to habituate to the standard stimuli and dishabituate to the post stimuli.

The P300 component observed in the count (and therefore attend) condition of Group C, was predominantly centro-parietal with a waveform maximal at the Pz site. This finding is in agreement with other research on the scalp distribution of P300 according to Fabiani, Gratton, Karis, and Donchin (1987). There was also slight evidence of the P300 component in the Passive Attend Group D. The fact that P300 was elicited in the attend condition and not in any of the other experimental or control groups is also in agreement with previous findings (Pritchard, 1981; Fabiani et al., 1987). The research which has considered the effects of stimulus omission on the P300 confirms the findings of the present study in that omitted stimuli resulted in P300 elicitation only when subjects attended to the omissions (Klinke et al., 1968; Picton & Hillyard, 1974; Pritchard, 1981). In summary, the present findings suggest that focal attention to omitted stimuli was necessary to produce the P300. This supports the suggestion that processing of the omitted stimuli must be in the "attended to" channel to permit the issue of a call for further processing. The negativity preceding the onset of the P300 may be suggestive of the N2b/P3a complex postulated to be associated with issuing this "call" (Näätänen & Gaillard, 1983).

Future Research

There are a number of reasons why MMN may not have been elicited to the omitted stimuli. Firstly, the omitted stimuli may not have been compelling enough to register as deviant. That is, the contrast between the standard stimuli and omitted stimuli may have lacked sufficient magnitude to reach the threshold needed to facilitate a neuronal mismatch.

It is possible that if the standard stimuli in future research were presented at a rate and intensity which make it impossible to miss an omission that this might facilitate the mismatch process thus generating MMN. However, as subjects in this experiment did not miss very many omissions (at least in the counting condition) the latter suggestion is questionable. Alternatively, it may be possible to generate MMN by increasing the salience of the stimulus omission.

It is also possible that a combination of these two suggestions might produce MMN to omission. Reducing the inter-stimulus interval of the standard stimuli while both decreasing the probability of the deviant omissions and increasing their duration may prove to facilitate detection of omission deviants. The distinction between standard and deviant stimuli would then be more clearly delineated and would perhaps permit the integration of contextual information into the neural model in a similar manner to that suggested for the OR by (Siddle & Packer, 1987).

It is also possible that the attentional conditions used in this research were not optimal for the elicitation of MMN in response to omitted stimuli. It is suggested that an area worthy of further investigation would be to examine the effects of stimulus omission under escalating conditions of stronger attentional focus (i.e.; from simple attentional tasks such as reading through to attentional tasks demanding extraordinary processing resources such as requiring the subject to respond to slides of impending motor vehicle accident scenes within a reaction time paradigm. The demand on central processing resources under the latter conditions may distract the subjects active attention away from unintentional controlled processing of the presented stimuli. This arrangement may then provide a more valid assessment of MMN in response to omission (if in fact MMN is a preattentive process).

Paradoxically it may be the case that MMN is only elicited under conditions of strong attentional focus away from the deviant (rare) stimulus as suggested by the Woldorff et al. (1991) research. When the subjects attention is diverted very strongly away from the presented deviant stimuli such that automatic mismatch processes cannot be influenced by arbitrary attentional focus to the presented omissions, MMN may then be elicited to omitted stimuli.

Conclusions

In summary, the present research demonstrated that MMN was not elicited to omission under any of the attentional conditions employed in this study. There was evidence of negativity in the counting Group C which was characteristic of mismatch negativity but as was pointed out previously this was considered more likely to be the N2b component associated with the distinct P3a/P300 observed in this Group (C).

There was clear evidence of a dishabituation effect to the standard stimuli in the post trials of the Reading (Ignore) Group A primarily at fronto-central sites. This suggests that the standard tone immediately following a deviant stimulus presentation produced a recovery of response to pre-omission stimuli. There was also an obvious refractory period in all the experimental groups in the N1/P2 components post responses.

These current findings are of particular importance to the current debate in the literature concerning the relationship between the MMN component of the ERP and the OR. The evidence provided here, at least in terms of stimulus omission, points to a possible dissociation between the two processes. It will be necessary in future research to identify the peculiar attentional conditions that may be conducive to stimulus omission. It may be the case that stimulus omission is, paradoxically, observed only under conditions of strong attentional focus away from the deviant stimuli. Alternatively, stimulus omission may only induce MMN when experienced in other stimulus modalities. If the latter suggestion were true then this would provide substantial support for the suggestion that MMN and the OR are integrated since many of the OR responses to omission have been shown to be multimodal.

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Appendices Contents List

Letter Code	Appendix Item	Number of Pages
A	*Medical History Questionnaire*	2 pages
B	*Participant Consent Form*	1 page
C	*Comprehension Test*	1 page
D	*Raw Data File*	8 pages
E	*Relevant Data Analyses*	27 pages

University of Tasmania
Department of Psychology

Medical History Questionnaire

NAME..

AGE...PHONE...

Do you; A. Smoke Cigarettes................................ Yes ☐ No ☐
B. Use or have experimented with either drugs or marijuana ....
....Yes ☐ No ☐

Have you ever been a patient in a Mental hospital?......... Yes ☐ No ☐

Have you ever been a patient in any other hospital ?......... Yes ☐ No ☐

HAVE YOU EVER HAD OR ARE YOU NOW SUFFERING FROM ANY OF THE FOLLOWING;

Fits or Convulsions........................... Yes ☐ No ☐

Epilepsy... Yes ☐ No ☐

Giddiness...................................... Yes ☐ No ☐

Concussion...................................... Yes ☐ No ☐

Severe Head injury........................... Yes ☐ No ☐

Loss of Consciousness........................ Yes ☐ No ☐

CURRENT MEDICATION

Are you taking any medications at present ? ...... Yes ☐ No ☐
If YES, which Drugs are you taking?
....
....

HEARING

Have you any hearing difficulties? ...... Yes ☐ No ☐
If YES, indicate hearing defects ....
....

DRINKING HISTORY

On how many days last week did you drink alcohol ?...
- None ☐
- One or Two days ☐
- Five or Six Days ☐
- Every Day ☐

Do you usually drink...
- Never ☐
- During the Week ☐
- Friday Night ☐
- Week Ends Only ☐

When you drink is it Normally................................
- Light Beer ☐
- Beer or Cider ☐
- Wine ☐
- Mixed spirits ☐
- Straight Spirits ☐

On a day when you drink, how many drinks would you usually have?

- One or Two ☐
- Three to Five ☐
- Five to Eight ☐
- Eight to Twelve ☐
- More than Twelve ☐

How long have you been drinking at this level ?............

- Weeks ☐
- Months ☐
- Years ☐

Do you get drunk?...

- Never ☐
- Rarely ☐
- Once a Month ☐
- Once a Week ☐
- More Frequently ☐

Does your father get drunk?......................................

- Never ☐
- Rarely ☐
- Once a Month ☐
- Once a Week ☐
- More Frequently ☐

Does your Mother get drunk?...................................

- Never ☐
- Rarely ☐
- Once a Month ☐
- Once a Week ☐
- More Frequently ☐

Do you have any relatives whom you would consider to be alcoholic?

Yes ☐ No ☐

If YES, How many and what relationship are they to you? ....

....

....

<u>OTHER INFORMATION</u>

How often do you smoke Cigarettes ?..................

- Never ☐
- Less than 10 per day ☐
- 10 to 20 per day ☐
- 20 to 40 per day ☐
- Over 40 per day ☐

Note:

It is a formal requirement of the Ethics Committee of the University of Tasmania that the information provided on this questionnaire be held under security to comply with confidentiality regulations and to protect your privacy. You can be assured that information will be available only to the principal researcher and not to any other party. The questionnaire will be destroyed following the completion of the project.

Thankyou for your participation,

Appendix B - Consent Form

UNIVERSITY OF TASMANIA
DEPARTMENT OF PSYCHOLOGY

Cognitive Psychophysiology Research

Participant Consent Form

Information for participation in studies in the Cognitive Psychophysiology Laboratory.

NAME:..

Telephone Number:..

The research carried out in the Electroencephalographic Research Laboratory includes a number of continuing research projects. Our studies are concerned with understanding more about the nature of cognitive processes, brain activity and a variety of related phenomena. The success of our research depends, in large measure, upon the assistance of volunteers such as yourself. We would like to extend our appreciation to you for your participation in this experiment today.

Please sign and date this form after carefully reading the following section; Today I am volunteering to participate in a research study that involves the presentation of aural stimuli via headphones. I understand that this experiment involves the recording of **Event Related Potential's** from my brain which will be detected via sensors harmlessly placed on my scalp. *(These **Event Related Potential's** will occur in response to some tones which you will hear through the headphones. Because we are interested in the nature of your brains response to the sounds we will give you specific instructions about what you should attend to during the duration of the experiment. Listen carefully to the instructions given and don't be afraid to ask the experimenter for them to be repeated again.)*

As part of the experiment I will also be required to listen to the sounds presented on the headphones. I understand that the natural electrical activity of my brain will be detected and measured in this experiment and that as part of my participation I will be asked to discuss my experiences and reactions to the study. I also understand that I have the right to discontinue my participation at any point in the experiment, if I so desire, without any penalty whatsoever. I understand that I will receive pro-rata research participation credit for the time spent in the experiment prior to withdrawal.

I ....have read and understood the above information in regard to this research project and agree to participate in the experiment of my own free will and choice. I understand my rights in regard to my ongoing participation in the project.

Signed..

Date..

I have explained this project and the implications of participation in it to this volunteer and am satisfied that the consent is informed and that she/he understands the implications of participation.

Signed..

Date..

Appendix C
Comprehension Test

My Oedipus Complex by Frank O'Connor

1. Father's job was
- [ ] A Publican
- [ ] A Doctor
- [ ] A soldier in the army
- [ ] A factory worker

2. The childs name was
- [ ] Larry
- [ ] Robert
- [ ] Craig
- [ ] James

3. The boy called his feet
- [ ] Sally and Sam
- [ ] Mrs. Left & Mrs. Right
- [ ] Tiny & Tim

4. When Sonny arrived the boy was
- [ ] Overjoyed
- [ ] Sad
- [ ] Angry
- [ ] "Put Out"

The snows of Kilanmanjaro by Ernest Hemmingway

1. Kilamanjaro is in
- [ ] Japan
- [ ] India
- [ ] Africa
- [ ] North America

2. The story is about a man who has
- [ ] Gangreen
- [ ] A broken Leg
- [ ] Concussion
- [ ] Hypothermia

A Letter to God by Gregorio Fuentes

1. Lencho Grew
- [ ] Corn & Kidney bean Flowers
- [ ] Wheat
- [ ] Poppies
- [ ] Peas & Beans

2. Lencho was concerned about
- [ ] An approaching cyclone
- [ ] The need for rain
- [ ] Insects eating the crop

The Little Bouilloux Girl by Colette (France)

1. At the dance there were
- [ ] Italian men
- [ ] Parisian men
- [ ] Bouilloux men

The Ruby by Carrado Alvaro

1. The jewel was lost by the
- [ ] An Indian prince
- [ ] A French women
- [ ] A Dutch princess

Six Feet of Country by Nadine Gordimer

1. Lerice and her husband lived ten miles out of
- [ ] Ohio
- [ ] Cairo
- [ ] Johannesburg

Appendix D

Raw Data

	GROUP		FZ								
			PRE								
			INT2	INT3	INT4	INT5	INT6	INT7	INT8	INT9	INT2
1	GROUP A	OMISSION	-2.20	.80	-.80	-3.20	-2.50	-1.00	-1.10	-.20	-.20
2	(READ)	OMISSION	.30	.80	-2.20	-5.40	-2.60	.40	.60	.30	-.30
3		OMISSION	-3.00	-1.50	-2.20	-5.50	-3.10	-1.60	-2.00	-2.10	.10
4		OMISSION	-1.00	2.10	-.70	-1.90	-.70	-.30	1.10	1.00	1.50
5		OMISSION	-5.70	3.50	.50	-4.10	-3.60	-4.40	-4.20	-4.40	0.00
6		OMISSION	-1.90	2.00	-.60	-2.00	-2.40	-2.70	-2.00	-1.70	-.20
7		OMISSION	-6.40	.40	-.70	-3.00	-3.70	-2.90	-.80	1.80	-1.20
8		OMISSION	-3.50	-.10	-1.60	-4.50	-3.10	-.90	-.80	-1.60	.40
9		OMISSION	2.00	5.40	3.20	-.50	-1.10	-1.30	-1.00	-.30	-.20
10		OMISSION	-4.20	3.30	-2.10	-5.60	-2.60	-1.20	-1.50	-.90	-.70
11	GROUP B	CONTROL•1	-.90	3.10	.80	1.10	1.00	.60	.30	-.20	-1.10
12	(READ)	CONTROL•1	.40	-.10	-1.40	-1.10	-1.80	-1.30	-1.50	-1.90	.10
13		CONTROL•1	1.40	2.60	.70	-1.20	-.40	.50	1.20	1.30	1.90
14		CONTROL•1	.10	3.20	1.00	-1.90	-.80	-1.40	-.50	-.20	-.50
15		CONTROL•1	-4.60	-2.00	-4.40	-6.00	-5.30	-5.30	-5.90	-6.20	-3.70
16		CONTROL•1	-2.10	.20	-1.40	-3.80	-4.50	-3.40	-2.00	-2.00	-2.00
17		CONTROL•1	-1.40	3.20	-.50	-1.10	-1.40	0.00	.80	.20	-2.50
18		CONTROL•1	-2.00	.20	-2.00	-4.80	-5.20	-4.40	-2.40	-1.40	-1.00
19		CONTROL•1	-.60	2.00	-.50	-3.00	-2.80	-1.50	-.20	-.60	-1.20
20		CONTROL•1	-3.60	0.00	-2.80	-2.00	-.60	-1.00	-.70	-1.40	-3.20
21	GROUP C	COUNTING	-3.60	-1.70	-1.80	-3.60	-3.30	-2.70	-2.40	-1.70	-.70
22	(COUNT)	COUNTING	-3.30	-3.90	-3.40	-2.50	-2.30	-1.00	-1.00	-.90	-.80
23		COUNTING	-1.80	4.50	7.10	1.40	-1.50	-3.40	-2.70	-2.40	-.70
24		COUNTING	-1.50	.30	-3.90	-4.40	-3.60	-4.10	-4.00	-2.00	-.70
25		COUNTING	-2.40	-1.40	-2.80	-3.40	-2.10	-.50	-2.50	-2.00	-1.10
26		COUNTING	-4.30	1.20	-.50	-2.40	-2.00	-2.50	-1.80	-.50	-.70
27		COUNTING	-2.90	.30	-1.50	-3.20	-6.10	-3.90	-3.60	-3.70	.50
28		COUNTING	-.20	2.20	2.10	.30	-.60	.40	.10	.80	-.50
29		COUNTING	-1.50	1.00	-1.10	-3.50	-3.80	-4.00	-4.70	-3.20	.70
30		COUNTING	-3.30	-.50	-.30	-.40	-.10	-.20	-1.40	-1.30	-2.80
31	GROUP D.	PASSIVE	-3.40	2.80	1.40	-1.50	-3.20	-2.20	-1.40	-2.00	-.40
32	(PASSIVE	PASSIVE	-.20	5.00	2.80	.40	-.70	-.90	-1.80	-.50	-2.30
33	ATTEND)	PASSIVE	-1.50	2.10	-.70	-3.30	-5.70	-6.00	-6.20	-3.90	.10
34		PASSIVE	.40	4.30	-1.00	-5.10	-3.30	-2.00	-2.50	-2.10	.50
35		PASSIVE	-1.90	1.00	-2.20	-5.10	-5.30	-3.70	-3.90	-2.80	-1.70
36		PASSIVE	-3.90	-2.20	-4.30	-5.40	-5.20	-4.00	-2.40	-1.60	0.00
37		PASSIVE	-.50	3.10	1.30	-.70	-.80	-1.30	-.90	-.50	.30
38		PASSIVE	-8.70	1.60	-1.40	-4.10	-4.70	-1.50	-1.50	0.00	-1.50
39		PASSIVE	-2.30	1.70	-2.10	-4.10	-4.10	-2.30	-2.10	-1.40	1.00
40		PASSIVE	-2.40	-1.10	-2.40	-3.50	-1.10	-1.50	-.90	-2.00	-1.40
41	GROUP E	CONTROL•2	.40	3.30	.40	-2.60	-1.60	-2.40	-1.00	-2.00	.60
42	(PASSIVE	CONTROL•2	-.90	1.80	-1.20	-2.70	-1.70	-3.80	-3.60	-3.40	-.60
43	ATTEND)	CONTROL•2	-2.20	.10	-1.80	-1.70	.50	.30	-.30	-.60	-3.60
44		CONTROL•2	-6.60	-1.00	-4.20	-7.00	-6.00	-4.90	-4.10	-3.30	-4.70
45		CONTROL•2	-4.70	-2.00	-5.70	-7.30	-6.50	-5.90	-4.80	-3.60	-4.20
46		CONTROL•2	-2.50	3.00	2.30	-.90	-1.20	-.70	.20	1.40	-5.50
47		CONTROL•2	0.00	.20	-1.30	-2.70	-1.30	.50	2.10	1.50	-.10
48		CONTROL•2	-1.10	3.00	-.30	-4.80	-6.00	-5.10	-4.20	-4.10	-1.20
49		CONTROL•2	-2.70	1.40	.50	-3.50	-3.40	-2.00	-1.80	-3.30	-3.70
50		CONTROL•2	.20	2.00	-1.20	-3.50	-4.60	-3.30	-2.80	-1.90	.90

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	FZ							F Z			
	RARE							POST			PO
	INT3	INT4	INT5	INT6	INT7	INT8	INT9	INT2	INT3	INT4	INT5
1	-.50	-.20	-.20	0.00	0.00	.50	.10	-4.50	-1.90	-1.40	-3.20
2	-1.80	-2.30	-1.50	-.90	-.30	.10	-.20	-.10	-.80	-1.70	-6.60
3	-.10	-.50	-.50	0.00	.20	.30	-.50	-4.30	-1.40	-.30	-3.00
4	1.20	1.80	1.70	2.60	2.70	2.30	2.40	-2.80	.40	-1.90	-4.10
5	-1.00	-.40	.20	-.80	-.50	-.60	-.50	-6.60	5.70	3.00	-2.00
6	0.00	-.30	-.40	-1.00	-.80	-.50	-.10	-4.00	2.00	.20	-2.70
7	-.80	-.70	-1.40	-.90	-1.20	-.80	.10	-9.30	-2.10	0.00	-.30
8	0.00	-.10	-.40	.40	.70	.80	.50	-4.60	.50	-1.20	-4.40
9	-.50	.30	0.00	.20	1.00	.60	.40	-2.00	3.90	4.60	-2.10
10	-2.10	-2.90	-2.90	-2.90	-2.40	-2.70	-3.10	-6.40	1.10	-.80	-5.70
11	3.10	.20	.40	.80	.10	-.10	0.00	-1.70	2.70	-.30	-1.10
12	0.00	-1.00	-1.10	-1.00	-1.00	-.90	-.90	.10	-.60	-.90	-1.10
13	3.10	1.00	-1.40	.40	.60	.70	.90	1.30	3.20	1.90	-1.00
14	1.50	-.90	-3.10	-3.20	-3.40	-3.50	-3.30	0.00	2.50	.80	-2.00
15	-.40	-3.10	-4.70	-5.40	-5.40	-4.80	-6.30	-1.70	1.00	-1.40	-2.40
16	.80	-1.90	-4.30	-4.20	-3.10	-2.80	-2.90	-1.40	1.50	-.90	-4.20
17	2.40	-.10	-1.00	-1.30	-.40	.40	-.60	-3.30	.50	-2.20	-1.80
18	.40	-2.20	-4.10	-4.70	-2.80	-.30	-.50	-1.50	.50	-2.00	-4.90
19	2.20	.90	-2.90	-2.20	-1.40	-.90	-.30	-.50	2.60	-.30	-1.80
20	1.00	-2.10	-1.80	-.20	-.73	.60	.30	-3.60	0.00	-2.80	-2.00
21	-.10	.60	2.80	4.00	2.90	-.50	-3.00	-5.00	-1.20	-.50	-2.20
22	-1.30	-1.10	-.80	-.90	0.00	-.20	-.80	-5.30	-5.70	-4.20	-4.10
23	.10	-2.20	-1.20	-.60	-.20	-.20	-.70	-2.10	3.30	8.10	1.30
24	-1.90	-2.20	-1.60	-1.10	.60	.90	-.20	.60	1.70	-.30	.20
25	-1.40	-2.10	-1.70	-1.70	.10	-.30	.30	-2.50	-.30	0.00	-3.70
26	-2.40	-1.70	-2.40	-2.80	-3.10	-4.40	-5.30	-4.80	2.50	2.50	.60
27	.60	-1.10	-1.20	-.80	-.90	-1.10	-3.60	-5.00	.70	.50	-1.60
28	-1.10	-2.40	-1.20	1.00	3.30	3.80	4.50	-2.00	1.90	3.30	2.00
29	-.20	-.40	-.30	-1.80	0.00	1.80	1.20	-3.40	-1.20	-3.50	-4.30
30	-5.00	-6.60	-5.90	-4.10	-.40	.90	-.50	-6.40	-3.00	-2.40	-1.90
31	-.90	-1.50	-1.50	-1.40	-1.20	-2.00	-2.90	-6.00	-1.60	1.90	-1.20
32	-3.30	-3.40	-2.80	-2.20	-2.30	-2.80	-3.40	-2.80	2.80	4.80	1.10
33	-.50	1.40	-.60	0.00	-.90	-.30	.30	-2.90	2.20	.80	-.20
34	-.80	-.40	-1.80	-1.50	-1.60	-1.80	-2.70	-3.10	2.20	.10	-5.60
35	-2.80	-3.10	-2.90	-3.50	-2.60	-3.40	-4.60	-3.50	-.30	-.30	-3.50
36	-.80	-.40	.30	1.90	3.30	3.40	2.70	-3.60	-.40	-1.40	-3.30
37	-.20	.20	1.80	1.00	2.10	2.20	2.10	-1.10	3.50	1.40	-1.30
38	-2.10	-2.50	-2.00	-2.10	-1.80	-1.50	-.90	-12.80	1.90	1.20	-7.30
39	1.00	.60	.10	1.40	1.60	2.00	1.60	-3.90	1.00	-.50	-3.60
40	-.60	-1.40	-1.00	-.10	1.40	1.80	1.40	-2.90	-1.00	-2.40	-3.50
41	3.20	1.20	-2.50	-.90	-1.10	-.60	-1.00	1.10	4.00	1.80	-2.20
42	1.50	.20	-2.10	-2.70	-3.10	-1.80	-1.30	-.40	3.00	1.10	1.00
43	-.80	-1.70	-1.20	-.60	-1.50	-1.40	-1.10	-2.40	1.00	-2.20	-3.10
44	1.90	-2.70	-4.80	-4.70	-4.00	-2.10	-1.30	-6.30	-1.00	-4.90	-8.10
45	-2.20	-4.40	-7.30	-6.10	-5.00	-4.20	-2.40	-4.00	-2.00	-5.70	-8.30
46	0.00	.10	-3.20	-3.80	-2.50	-1.20	-.30	-3.80	1.90	1.30	-1.30
47	-.50	-2.00	-3.20	-2.70	-1.30	.10	-1.10	-.30	1.40	-.30	-2.70
48	3.30	1.10	-4.40	-5.20	-4.90	-4.00	-3.60	-2.90	1.60	-1.00	-5.60
49	-.50	-2.20	-5.20	-4.40	-4.50	-4.60	-3.50	-3.30	.60	-.20	-3.10
50	2.70	.30	-1.90	-3.00	-2.00	-1.60	-2.20	.80	3.60	.40	-1.80

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	FZ				CZ						
	ST POST				PRE						
	INT6	INT7	INT8	INT9	INT2	INT3	INT4	INT5	INT6	INT7	INT8
1	-2.80	-1.30	-1.80	-1.50	-2.70	.50	-.30	-2.70	-3.00	-1.00	-1.10
2	-4.20	-1.40	-1.50	-2.00	-.10	1.50	-1.60	-4.60	-2.60	-.50	0.00
3	-1.60	2.20	1.00	-.10	-3.10	-1.00	-.50	-4.70	-3.70	-2.30	-1.70
4	-3.60	-3.60	-3.50	-3.10	-1.10	3.00	-.30	-2.30	-1.30	-1.00	-.10
5	-2.60	-3.50	-3.10	-4.90	-6.00	2.80	1.10	-2.90	-2.00	-4.00	-2.60
6	-4.30	-3.40	-3.30	-3.90	-2.60	2.30	-.10	-2.00	-2.00	-1.80	-1.20
7	-3.90	-2.60	-2.70	-.10	-7.50	1.70	.50	-3.40	-5.40	-4.00	-.70
8	-3.00	-1.60	-1.50	-2.00	-2.70	.60	-.80	-3.60	-2.40	-.90	-1.10
9	-3.20	-3.20	-3.90	-3.80	1.00	5.00	3.20	-.30	-1.00	-.90	-1.30
10	-3.00	-1.30	-5.30	-5.40	-5.30	4.60	-1.30	-5.20	-3.00	-1.60	-1.90
11	-1.20	-1.80	-1.70	-1.20	-1.90	3.10	.10	.10	.20	-.10	-.50
12	-1.40	-1.40	-1.40	-.90	.20	.40	-1.00	-.80	-1.70	-1.10	-.90
13	-.80	-.70	-.50	0.00	.80	3.30	1.00	-1.50	-.90	.10	.70
14	-1.40	-1.60	-.40	-1.50	-.20	3.70	1.20	-2.50	-1.30	-2.00	-1.30
15	-1.30	-1.00	-2.10	-2.60	-4.30	-2.30	-4.00	-6.10	-6.40	-6.20	-6.10
16	-5.00	-3.80	-3.00	-4.00	-2.90	1.10	-.40	-3.00	-3.40	-2.60	-1.50
17	-2.30	-.80	-.10	-1.20	-1.50	1.70	-1.60	-2.00	-2.60	-1.90	-.80
18	-4.80	-2.30	-.50	.80	-1.90	.80	-.20	-3.00	-4.30	-3.50	-1.10
19	-1.00	-.90	.20	.30	-1.50	1.40	-.20	-2.50	-3.30	-.90	-1.30
20	-.60	-1.00	-.70	-1.40	-3.10	.90	-2.20	-1.90	-1.70	-1.70	-.50
21	-3.00	-2.90	-2.70	-1.70	-2.80	.40	.20	-2.00	-2.90	-2.00	-1.70
22	-4.30	-3.30	-4.40	-4.40	-3.20	-3.20	-2.50	-1.50	-1.20	.10	-.10
23	-1.80	-1.00	-1.10	-1.30	-1.00	5.40	6.80	1.40	-2.60	-3.00	-2.60
24	-.20	-1.90	-1.10	-.50	-1.10	1.80	-2.40	-3.40	-2.90	-3.60	-3.50
25	-3.50	-1.70	-2.10	-1.00	-2.20	.10	-1.30	-3.30	-2.10	-.90	-2.50
26	.90	1.20	-.60	.60	-3.60	2.00	1.10	-1.60	-2.40	-2.90	-2.00
27	-7.00	-3.30	-3.20	-3.50	-2.80	.60	-.10	-3.30	-5.90	-3.00	-3.00
28	-.10	.10	.90	2.80	.30	4.30	3.30	-.50	-.80	0.00	0.00
29	-4.20	-4.40	-3.30	-4.80	-1.40	2.90	.50	-2.20	-2.80	-3.00	-3.50
30	-3.80	-3.30	-4.20	-5.00	-3.50	.20	1.30	.60	.30	.40	-.40
31	-3.20	-2.20	-1.70	-2.90	-3.70	2.30	2.30	-1.00	-2.90	-1.70	-2.10
32	-1.70	-1.80	-3.10	-1.70	-.50	6.00	4.10	1.90	.10	-.80	-1.50
33	-2.20	-3.90	-4.60	-2.70	-.90	4.00	1.50	-1.80	-4.10	-4.70	-3.80
34	-3.60	-3.40	-1.70	-3.10	.50	5.00	.20	-3.70	-1.80	-.80	-1.40
35	-4.80	-5.00	-5.70	-4.30	-1.80	3.00	-.40	-4.70	-4.60	-3.60	-3.20
36	-4.00	-1.90	-.70	-1.00	-4.00	-.10	-2.00	-3.90	-4.20	-5.00	-4.20
37	-.10	-1.70	-1.10	-1.30	-1.40	3.40	1.40	-1.20	-1.60	-2.10	-1.90
38	-7.60	-3.20	-2.30	-4.90	-6.90	1.60	-.40	-2.90	-3.30	-1.60	-.70
39	-3.60	-2.90	-3.60	-4.20	-2.20	3.20	-.50	-3.20	-3.00	-1.30	-1.10
40	-1.20	-.60	-.50	-.70	-.30	3.20	1.30	-1.20	1.80	.90	1.80
41	-1.30	-1.80	-.50	-1.10	-.80	2.40	.60	-2.00	-.50	-2.20	-1.20
42	.70	-.70	0.00	.40	-2.00	1.80	-1.10	-1.40	-1.60	-4.20	-3.20
43	.30	-.20	-.10	1.00	-3.30	1.60	.40	-.20	1.80	.50	-.50
44	-6.10	-4.80	-4.40	-2.90	-6.80	.10	-2.70	-5.40	-5.30	-4.70	-3.80
45	-7.50	-6.90	-6.00	-5.00	-4.60	-1.10	-5.00	-6.00	-6.80	-6.60	-5.40
46	-1.20	-.40	-.30	-1.30	-2.60	3.10	2.40	-.60	-1.60	-.70	-.30
47	-2.00	-1.30	1.30	.30	-.20	.30	-.90	-1.90	-1.10	.50	1.10
48	-7.10	-7.10	-4.90	-4.70	-2.00	4.90	4.00	-2.90	-4.40	-3.80	-3.30
49	-3.00	-2.60	-3.00	-2.30	-2.80	1.70	1.50	-1.70	-1.70	-.50	-.50
50	-2.40	-1.40	-1.40	-.90	.10	2.00	-1.50	-3.40	-4.20	-3.40	-2.30

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	AMPLITUDE									
	CZ									
	PRE	RARE								
	INT9	INT2	INT3	INT4	INT5	INT6	INT7	INT8	INT9	INT2
1	-.60	-.40	-1.10	-.80	-.90	-.40	-.40	-.10	-.70	-5.00
2	-.80	0.00	-1.30	-1.30	-.50	.50	1.40	1.60	1.20	-.20
3	-2.40	1.00	.20	-.60	-.70	-.10	0.00	.80	.70	-4.80
4	.10	1.00	1.10	1.80	2.20	3.40	3.00	2.30	2.10	-2.20
5	-3.30	.50	-1.20	.10	-.20	-.30	-.90	-.60	-.10	-6.00
6	-1.40	0.00	.20	.10	.40	-.30	-.20	.10	.20	-4.40
7	.20	-1.60	-.80	-.90	-2.30	-2.40	-2.50	-1.90	-.20	-9.90
8	-1.60	.40	-.20	0.00	-.40	-.90	.40	.20	.10	-3.50
9	-.50	-.10	-.80	-.40	-.50	0.00	.80	.20	.80	-2.90
10	-1.50	-.90	-2.00	-3.10	-2.50	-3.30	-2.70	-3.00	-3.80	-8.90
11	-.40	-2.30	2.90	-.40	.10	.30	-.20	-.70	-.10	-2.80
12	-1.30	-.10	.50	-.60	-.30	-.50	-.60	-.40	-.40	-.30
13	.80	1.40	3.90	1.30	-1.30	.40	1.10	1.10	1.00	.10
14	-.80	-1.10	1.90	-.40	-3.00	-2.70	-3.10	-3.40	-3.50	-.90
15	-7.00	-4.40	-1.00	-3.00	-4.90	-6.50	-6.20	-5.00	-6.90	-2.20
16	-1.90	-3.40	1.60	-1.20	-3.90	-3.90	-3.40	-3.20	-3.10	-2.20
17	-1.40	-2.60	1.90	.20	-.40	-1.00	-.60	.60	-.10	-3.20
18	-.90	-1.80	.70	-2.00	-3.00	-4.30	-2.30	.20	-.90	-.80
19	-1.20	-2.30	1.80	1.00	-2.90	-2.80	-2.50	-1.60	-.90	-.70
20	-.50	-3.40	1.70	-1.30	-1.10	-.10	-.40	.50	0.00	-4.20
21	-1.40	0.00	.90	3.20	6.80	8.10	6.20	1.60	0.00	-4.50
22	-.20	-1.20	-1.60	-1.10	-.60	.20	1.70	2.10	2.10	-5.60
23	-2.70	-1.60	-.50	-2.60	-1.40	-1.10	1.20	1.20	1.60	-1.70
24	-2.50	-.60	-.80	-.30	1.80	4.20	7.80	9.30	9.20	.80
25	-2.20	-1.90	-2.60	-2.70	-1.90	-.60	1.40	1.60	2.30	-3.40
26	-1.00	-.50	-1.70	-1.50	-1.70	-1.50	-1.10	-2.10	-2.40	-4.80
27	-3.10	.50	1.80	.80	1.60	3.70	5.60	6.00	3.80	-3.80
28	.40	-1.20	-1.20	-1.60	-.40	2.50	6.40	8.60	10.40	-2.30
29	-2.80	0.00	0.00	-.70	-.80	-1.00	.40	2.60	3.50	-3.70
30	-.40	-2.70	-5.00	-6.50	-5.10	-.90	4.50	6.10	4.60	-6.20
31	-2.70	-.70	-1.00	-1.60	-2.10	-1.60	-1.50	-2.50	-3.30	-5.80
32	-1.10	-1.90	-3.40	-3.30	-3.60	-3.90	-3.30	-2.90	-1.90	-2.60
33	-2.30	.20	-.10	1.70	.20	.40	-.50	.30	.70	-2.70
34	-1.70	.90	-.30	-.50	-1.60	-1.00	-1.00	-1.30	-2.60	-4.70
35	-2.40	-1.30	-2.10	-1.90	-1.70	-2.00	-.80	-1.60	-2.60	-3.20
36	-3.50	-.30	-.80	0.00	.80	2.80	4.60	5.00	4.00	-4.10
37	-1.20	-.50	-.90	.20	1.50	.60	1.80	1.70	1.20	-2.30
38	0.00	-1.90	-3.00	-3.90	-4.20	-4.20	-3.90	-1.90	-1.00	-10.70
39	0.00	1.20	1.50	1.30	1.40	2.30	2.40	2.80	2.20	-5.20
40	.60	-.50	1.60	1.60	2.20	3.70	4.00	3.70	4.20	-.70
41	-2.10	.20	3.20	1.60	-1.20	0.00	-.70	.10	-.50	-.70
42	-3.80	-.60	2.30	1.30	.70	-.60	-1.70	.20	0.00	-1.00
43	-1.40	-4.10	.60	0.00	.10	.20	-.40	-.60	-1.70	-2.60
44	-3.10	-5.40	2.90	-1.00	-2.70	-3.80	-3.30	-1.40	-.80	-6.80
45	-4.70	-4.00	-1.40	-4.40	-6.90	-6.30	-6.10	-5.20	-3.50	-4.20
46	.40	-5.70	.90	1.50	-2.20	-2.90	-1.90	-1.20	-.10	-5.40
47	.20	.20	.70	.30	-2.50	-1.00	-.60	1.30	.10	.40
48	-3.40	-1.90	4.80	4.00	-3.10	-4.30	-2.20	-3.10	-2.90	-3.40
49	-1.90	-4.30	-.60	-1.30	-4.70	-4.70	-3.80	-3.70	-3.30	-3.20
50	-1.60	.40	2.60	-.40	-2.10	-3.50	-2.60	-1.90	-1.70	.70

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	CZ							PZ		
	POST							PRE		
	INT3	INT4	INT5	INT6	INT7	INT8	INT9	INT2	INT3	INT4
1	-2.00	-.80	-2.70	-3.50	-1.80	-2.20	-1.90	-1.40	.20	-.30
2	.90	.30	-5.40	-3.90	-1.90	-2.40	-1.50	-.60	1.20	-1.10
3	-1.10	2.90	-.60	-1.70	2.40	2.10	.10	-1.80	-.50	.20
4	2.00	-.10	-3.50	-3.40	-3.60	-3.50	-3.00	-.90	1.30	-.80
5	5.10	3.30	-.60	-.50	-2.80	-2.70	-3.50	-4.20	0.00	-.90
6	1.90	1.20	-2.70	-4.40	-3.30	-3.10	-4.10	-2.20	1.10	-.40
7	1.60	4.90	.40	-6.30	-4.40	-1.40	1.90	-5.20	1.60	.10
8	1.30	-.10	-3.10	-2.30	-1.60	-1.90	-1.80	-1.40	.40	-.70
9	4.40	6.20	-.70	-2.50	-3.20	-3.60	-3.10	.40	2.30	.90
10	4.00	4.20	-3.70	-4.00	-5.40	-6.60	-5.30	-3.70	2.90	-1.10
11	3.00	-.30	-.80	-1.00	-1.60	-.80	-.70	-1.30	1.50	-.30
12	-.50	-1.00	-.70	-1.30	-1.50	-1.40	-.80	0.00	.50	-.80
13	3.50	1.20	-2.40	-2.20	-1.80	-1.10	-1.10	.20	1.60	.10
14	2.70	.90	-2.80	-1.90	-1.70	-1.00	-2.00	-.20	2.70	.80
15	.40	-1.30	-2.50	-2.20	-1.40	-2.40	-3.20	-2.30	-2.70	-3.60
16	2.20	-.70	-4.10	-4.70	-3.10	-2.70	-3.90	-2.10	.90	.20
17	-.10	-1.80	-1.60	-1.90	-.40	.70	-.50	-1.10	-.20	-2.90
18	.90	-1.40	-4.40	-4.90	-2.60	-.60	-.60	-1.10	.90	.20
19	2.50	.30	-.60	-1.50	-1.10	0.00	.10	-1.70	-.40	-.90
20	.50	-2.10	-1.60	-.90	-1.00	-.50	-2.00	-2.50	.40	-1.30
21	.90	3.20	-.20	-2.90	-3.10	-2.30	-1.70	-.80	.40	.80
22	-4.60	-2.10	-1.50	-2.50	-2.20	-3.50	-3.50	-1.40	-1.00	-.20
23	3.60	8.20	.70	-2.70	-2.00	-1.00	.50	-.90	1.30	2.00
24	3.40	1.10	1.20	0.00	-1.70	-1.20	-.70	-1.30	1.00	-1.20
25	-.10	.70	-3.60	-4.20	-2.30	-1.50	-1.40	-1.90	-.60	-.70
26	1.80	4.20	1.10	-.90	-.10	-.40	1.20	-2.10	0.00	.80
27	1.60	4.80	1.80	-4.80	-2.30	-2.40	-1.40	-1.90	-.50	-.50
28	4.30	6.20	2.80	.70	1.10	.50	2.50	.40	3.20	1.40
29	-1.40	-2.40	-2.20	-3.40	-3.50	-2.90	-5.20	-.70	2.10	1.70
30	-1.90	.30	1.10	-1.40	-1.50	-1.90	-2.90	-2.10	0.00	1.60
31	-.40	5.90	2.30	-.50	-.70	-1.80	-3.10	-2.60	.80	1.00
32	5.60	9.70	6.30	-.10	-.20	-1.80	-.90	.10	4.90	2.30
33	5.20	4.90	.70	-4.00	-3.50	-4.00	-1.10	-1.90	2.40	1.80
34	2.60	2.80	-4.60	-2.80	-3.30	-.90	-2.50	-.50	1.80	.40
35	3.00	4.80	-.10	-2.70	-3.90	-4.80	-3.40	-1.50	2.50	.40
36	1.70	2.20	-.40	-1.40	-.90	-.50	-1.50	-2.60	.10	-.70
37	3.90	2.30	-1.80	-1.00	-2.10	-1.60	-1.90	-.30	1.40	0.00
38	.80	1.80	-5.70	-6.90	-4.30	-1.60	-4.70	-2.20	2.70	.80
39	2.60	1.50	-2.80	-4.20	-3.20	-3.30	-3.50	-1.60	1.40	.20
40	5.80	4.30	.60	1.70	1.30	1.60	1.10	0.00	1.10	.70
41	3.20	1.80	-.80	-.50	-1.30	.30	-.40	-1.10	.80	.10
42	3.10	1.50	2.50	1.30	0.00	.60	.30	-1.90	.80	-1.60
43	1.10	-.80	-1.00	1.70	.20	-.30	-.30	-2.00	.20	.50
44	.30	-3.70	-7.20	-6.10	-5.40	-4.80	-3.80	-5.10	.50	-1.20
45	-1.00	-5.50	-7.60	-7.20	-7.80	-6.60	-5.60	-2.80	0.00	-1.90
46	1.00	1.30	-.50	-1.00	-.50	-1.00	-2.30	-1.40	1.90	2.00
47	2.90	2.00	0.00	.20	-.10	1.70	-.10	.30	.60	-.60
48	3.50	3.20	-3.40	-6.40	-5.10	-3.70	-3.80	-1.20	4.40	2.70
49	1.10	.30	-2.50	-2.80	-2.00	-2.30	-1.90	-1.80	.80	.80
50	3.70	0.00	-2.50	-3.80	-2.10	-1.80	-1.10	-.30	.50	-1.00

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	PZ									PZ
	PRE					RARE				
	INT5	INT6	INT7	INT8	INT9	INT2	INT3	INT4	INT5	INT6
1	-1.50	-1.80	-.60	-.50	-.30	-.60	-1.50	-1.10	-1.50	-1.00
2	-3.10	-2.60	-1.60	-.80	-1.40	-.10	-1.00	-.80	-.90	-.20
3	-2.70	-2.40	-1.80	-.90	-1.70	.50	0.00	-.80	-.70	0.00
4	-1.60	-.90	-.40	-.10	-.30	.20	.40	.60	.90	1.90
5	-2.90	-1.40	-3.00	-1.20	-3.10	1.00	-1.00	.90	-.30	.50
6	-1.60	-.90	-.90	-.60	-1.00	0.00	-.10	-.10	.10	-.20
7	-2.10	-2.80	-2.30	-1.00	-1.40	-1.10	-.90	-1.40	-2.10	-1.60
8	-2.30	-1.80	-1.40	-1.90	-2.00	.20	-.10	-.10	-.20	-.70
9	-.40	0.00	.60	-.70	-.20	-.80	-1.40	-1.90	-1.70	-1.30
10	-3.30	-1.50	-.60	-1.60	-1.20	-.60	-1.60	-3.20	-2.70	-3.80
11	-.30	.40	.20	-.10	.10	-2.60	-.10	-1.70	-1.00	-.60
12	-.50	-.90	-.70	-.50	-.80	-.40	.30	-.50	-.10	0.00
13	-1.30	-.60	-.50	-.40	-.30	.40	1.50	.20	-1.20	.20
14	-2.30	-1.00	-1.40	-1.10	-.80	-1.20	1.00	-.70	-3.00	-2.00
15	-4.40	-4.70	-4.60	-4.70	-5.50	-3.40	-2.20	-3.80	-4.50	-5.70
16	-1.50	-1.00	-1.50	-.90	-1.10	-2.80	1.00	-1.00	-2.40	-1.60
17	-2.10	-1.50	-1.20	-1.10	-1.20	-1.10	1.20	-.40	-1.20	-.40
18	-1.20	-1.40	-1.50	-.10	-.80	-1.70	.70	-1.80	-1.30	-2.70
19	-1.80	-2.90	-.80	-1.50	-1.30	-1.50	.30	-.20	-2.10	-2.30
20	-1.10	-.90	-.80	0.00	.20	-2.30	1.20	-.50	.10	.90
21	.60	-.20	.10	-.60	-.30	0.00	.50	1.60	3.30	5.30
22	.30	.40	1.20	.80	.40	-.80	-1.10	-.60	-.40	.70
23	-.20	-1.80	-1.50	-2.90	-3.10	-.90	-1.60	-1.90	-1.70	-1.40
24	-2.40	-2.20	-3.50	-2.70	-2.70	-.30	0.00	.70	2.20	5.10
25	-2.40	-.70	-1.30	-2.10	-2.30	-2.90	-4.70	-3.50	-4.40	-1.40
26	-.70	-1.30	-1.50	-2.00	-1.10	-.80	-1.40	-1.60	-1.20	0.00
27	-2.00	-2.70	-1.50	-2.10	-1.70	0.00	1.00	.50	2.80	5.40
28	-.90	-1.00	.20	-.30	0.00	-1.80	-1.70	-1.40	-1.60	2.40
29	-.20	-.70	-1.10	-2.00	-2.00	.20	.30	-.40	-.50	-.10
30	1.30	.60	0.00	-.80	-1.10	-2.10	-3.20	-3.10	-1.90	3.10
31	.30	-.90	-.30	-1.70	-2.00	-1.80	-1.50	-2.20	-2.80	-2.70
32	3.00	1.70	.50	.80	-.20	-.90	-2.90	-2.50	-3.70	-4.80
33	.20	-.60	-2.40	-1.70	-1.90	0.00	-.60	1.00	-.10	-.30
34	-1.30	.20	-.20	-1.00	-1.50	.30	-.60	-.90	-2.60	-.90
35	-2.30	-1.50	-2.40	-1.50	-1.30	-1.10	-1.00	-1.20	-1.20	-1.00
36	-1.80	-2.00	-3.30	-3.40	-3.30	-.60	-.60	-.40	-.40	1.60
37	-1.40	-.90	-.70	-.70	.30	-1.00	-1.80	-.30	.60	.30
38	-.90	1.00	-1.10	1.60	1.30	-1.80	-1.90	-3.40	-5.40	-4.70
39	-1.60	-1.20	-.20	-.40	-.30	.70	1.20	.20	.50	.80
40	-1.30	1.40	.20	1.70	.60	-1.30	-.20	.30	-.20	.50
41	-1.20	.90	-1.00	-.60	-1.70	-.60	2.10	.50	.30	.80
42	-1.30	-.10	-1.90	-2.00	-3.50	-.60	1.40	1.70	2.50	2.90
43	.70	1.70	-.80	-.80	-1.20	-3.20	.40	.50	1.00	.50
44	-2.70	-2.70	-2.80	-1.80	-1.70	-3.40	3.30	.50	.20	0.00
45	-2.90	-3.30	-3.50	-3.00	-3.00	-2.70	0.00	-1.80	-3.40	-2.60
46	1.30	-.10	-.60	-.80	.50	-3.70	-.40	1.60	.20	-.40
47	.40	.80	1.20	1.40	.90	.70	1.10	2.10	-.40	1.80
48	-1.30	-1.20	-.90	-.80	-1.50	-1.40	3.10	1.80	-2.30	-2.50
49	-.30	-.50	-.20	-.40	-1.40	-3.00	-.70	-.80	-2.60	-3.30
50	-1.20	-.90	-1.40	0.00	-.10	-.80	.70	-.70	-.70	-1.60

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	PZ									
				POST						
	INT7	INT8	INT9	INT2	INT3	INT4	INT5	INT6	INT7	INT8
1	-1.40	-.60	-1.10	-3.20	-1.50	-1.40	-1.10	-1.50	-.80	-.90
2	.60	1.10	1.10	-.90	1.20	1.10	-3.10	-2.40	-1.30	-1.30
3	-.40	.20	1.00	-2.70	-.20	3.20	1.90	.30	2.90	3.00
4	1.50	.80	.70	-1.80	.50	-1.00	-2.40	-1.50	-2.00	-2.30
5	-.80	-.40	-.80	-3.10	1.80	.70	-.60	1.90	-.30	0.00
6	-.10	.20	.50	-3.80	-.30	-.10	-2.10	-2.60	-1.60	-1.30
7	-1.90	-1.60	-.40	-7.60	.90	1.80	-.60	-3.30	-1.90	-.10
8	.10	-.20	-.10	-1.10	1.40	-.20	-2.20	-1.50	-1.60	-1.50
9	-.70	-.70	-.20	-2.60	2.00	2.30	-1.40	-1.00	-1.50	-1.70
10	-3.20	-3.30	-3.80	-6.20	1.20	1.70	-1.40	-.40	-2.60	-4.80
11	-.50	-1.10	-.80	-2.10	1.70	-1.10	-.30	-1.00	-.90	0.00
12	-.30	-.10	-.20	-.40	-.40	-.90	-.20	-.60	-.90	-1.00
13	.40	.10	.20	-.40	2.40	.40	-1.70	-1.50	-1.80	-1.00
14	-2.20	-2.40	-2.60	-.90	1.80	.40	-2.40	-1.60	-.90	-.80
15	-5.80	-5.20	-6.30	-1.20	-.80	-1.50	-1.80	-1.50	-.70	-1.00
16	-1.90	-2.20	-2.10	-1.80	1.40	-.50	-2.20	-1.90	-1.30	-1.60
17	.20	1.00	-.10	-2.70	-1.00	-2.20	-2.00	-.90	.30	.30
18	-.80	.60	-.60	-.50	.60	-1.00	-2.50	-2.50	-1.50	.30
19	-2.90	-1.80	-1.20	-.50	1.20	-.10	.30	-1.10	-.20	.40
20	.20	.50	0.00	-3.10	.20	-1.40	-.80	-.30	-.60	-.50
21	6.50	5.50	4.10	-1.70	.30	1.90	.40	-.50	-1.40	-1.10
22	2.10	3.10	3.70	-3.40	-2.30	-.50	.40	-.10	-.50	-1.70
23	1.80	1.20	2.70	-.40	2.20	3.00	.80	-.40	-.40	-1.10
24	9.20	11.30	11.90	0.00	2.10	.80	2.00	1.00	-.40	-.80
25	-.20	1.20	.80	-3.80	-2.10	-1.50	-4.40	-2.90	-2.10	-.20
26	2.00	2.70	2.60	-3.90	-2.00	2.20	1.40	.90	.50	-.70
27	8.80	10.20	9.80	-2.20	.70	2.20	1.20	-.10	.40	.50
28	6.00	8.70	10.00	-1.70	2.90	3.00	2.40	2.20	1.80	1.50
29	1.10	3.50	4.80	-2.90	-1.50	-1.80	-1.50	-2.30	-2.00	-2.50
30	8.20	10.10	8.30	-3.30	-.80	.90	2.00	1.00	.40	.40
31	-2.00	-2.30	-2.20	-4.30	-1.60	2.20	2.50	1.80	.90	-.80
32	-4.20	-4.20	-2.00	-.80	4.70	6.00	7.10	2.80	1.60	.40
33	-.50	-.50	.50	-2.70	4.40	3.70	3.60	-2.20	-.30	-3.40
34	-1.40	-.50	-1.10	-4.30	-.60	2.10	-2.00	1.20	-1.00	-.20
35	.80	1.20	.80	-2.00	3.20	4.20	3.00	2.50	0.00	-.90
36	3.50	4.90	5.10	-3.10	.70	1.10	.30	1.10	.10	-.30
37	.30	.80	-.40	-.80	1.50	.80	-1.20	-.10	-.10	-.70
38	-5.10	-1.70	-1.00	-4.40	-.20	0.00	-3.30	-2.40	-3.40	-.40
39	1.60	2.40	2.60	-4.60	.20	0.00	-1.60	-3.10	-3.00	-3.40
40	1.40	1.20	3.60	.10	4.70	3.10	-.10	1.80	1.00	1.80
41	.10	.50	-.20	-1.80	1.40	.40	0.00	.60	-.30	.30
42	1.10	3.00	2.00	-.70	2.20	1.00	3.00	3.70	2.90	2.30
43	-.60	-.90	-2.10	-1.30	.10	0.00	.40	.80	-.80	-1.50
44	-.60	.80	.90	-4.80	1.40	-1.50	-2.90	-2.30	-2.00	-2.10
45	-2.80	-2.50	-2.20	-2.80	-.10	-2.40	-3.70	-3.30	-4.20	-3.50
46	-1.20	-1.10	-.80	-4.40	.20	1.80	2.20	.70	.80	-.10
47	.30	2.60	1.40	-.30	2.60	1.50	1.90	1.50	1.20	.80
48	-1.00	-1.50	-1.50	-1.50	3.50	3.20	-1.10	-2.60	-1.00	-1.00
49	-2.50	-2.70	-2.70	-1.80	.80	1.10	-.50	-.50	-.20	-.40
50	-1.40	-.80	-.80	.30	2.00	.10	-.50	-1.20	-.20	-.20

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	P2 POST INT9	Input Column
1	-1.20	
2	-.70	
3	1.30	
4	-2.50	
5	-.40	
6	-2.40	
7	.90	
8	-1.00	
9	-1.30	
10	-3.90	
11	-.10	
12	-.60	
13	-1.00	
14	-1.50	
15	-2.20	
16	-2.80	
17	-.50	
18	-1.10	
19	.70	
20	-1.80	
21	-1.30	
22	-1.90	
23	.50	
24	-.50	
25	-2.40	
26	.60	
27	.50	
28	3.10	
29	-4.30	
30	-.70	
31	-1.40	
32	.30	
33	.10	
34	-1.30	
35	-.60	
36	-1.30	
37	-1.50	
38	-3.30	
39	-3.30	
40	.60	
41	-.30	
42	1.00	
43	-.80	
44	-1.90	
45	-3.40	
46	-.90	
47	.20	
48	-1.60	
49	.30	
50	.40	

Appendix E

Data Analyses

Anovas & Fisher LSD Post Hoc Tests

No	*Variables*	*Analysis*
E1	**Group (5) x Site (3) x Stimulus (3) x Interval (2-9)**	Four-way Anova
E2	**Group (5) x Site (3) for Pre Intervals 2-9**	Two-way Anova
E3	**Group (5) x Site (3) for Rare Intervals 2 - 9**	Two-way Anova
E4	**Rare Intervals: 3 (100-150msec) & 4 (150 200msec) for all Groups (5) at all Sites (3)**	Fisher LSDs
E5	**Rare Intervals: 6 (250-300msec), 7 (300-350msec), 8 (350-400msec) & 9 (400-450msec) for all Groups (5) at all Sites (3)**	Fisher LSDs
E6	**Group (5) x Site (3) for Post Intervals 2 - 9**	Two-way Anova
E7	**Post Intervals: 2 (50-100msec) & 4 (150 200msec) for all Groups (5) at all Sites (3)**	Fisher LSDs
E8	**Post Intervals: 5 (200-250msec), 6 (250-300msec) & 7 (300-350msec) for all Groups (5) at all Sites (3)**	Fisher LSDs

NOTE:

The significance criteria for all the above analyses was set at the .05 level. Greenhouse- Geisser corrections for repeated measures were used in all Anova analyses.

E1 - 4 way Anova

Group (5) x Site (3) x Stimulus (3) x Interval (2-9)

css/3: general manova	Summary of all Effects; design: 1-GROUP, 2-sitefcp, 3-stprq, 4-int2-9 (A-E; Fz Cz Pz; PRE/RARE/POST; INT 2-9.)						
Effect	df Effect	MS Effect	df Error	MS Error	F	p-level	GG.
1 GROUP	4	69.1232	45	75.30378	.91792	.461848	
*2 SITE	2	303.0588	90	6.66995	45.43644	.000000	.0001
*3 STIM(TONE)	2	168.4725	90	27.44209	6.13920	.003167	.0041
*4 INTERVAL	7	389.7734	315	8.02213	48.58729	0.000000	.0001
*12 GRP x SITE	8	31.5182	90	6.66995	4.72540	.000074	.0005
13 GRP x STIM	8	51.4840	90	27.44209	1.87610	.073472	.0800
*23 STIM x SITE	4	9.6205	180	1.76170	5.46089	.000358	.0039
*14 GRP x INT.	28	19.8362	315	8.02213	2.47268	.000087	.0041
*24 SITE x INT.	14	24.9741	630	.70587	35.38066	0.000000	.0001
*34 STIM x INT.	14	84.3465	630	2.47593	34.06655	0.000000	.0001
*123	16	11.1420	180	1.76170	6.32456	.000000	.0001
*124	56	2.0843	630	.70587	2.95288	.000000	.0001
*134	56	20.1177	630	2.47593	8.12529	.000000	.0001
*234	28	4.9461	1260	.26611	18.58644	0.000000	.0001
*1234 GRP x SITE x STIM x INTERVAL	112	1.8275	1260	.26611	6.86751	0.000000	.0001.

*Marked effects significant at p≤.0500

E2 - Two way Anova

Group (5) x Site (3) for PRE Interval 2

PRE

css/3: general manova	Summary of all Effects; design: 1-GROUP, 2-sitefcp (2)						
Effect	df Effect	MS Effect	df Error	MS Error	F	p-level	GG
1	4	5.184100	45	9.265206	.55952	.693170	
*2	2	8.259267	90	.528074	15.64035	.000001	.0001
12	8	.766850	90	.528074	1.45216	.186140	.2184

*Marked effects significant at p≤.0500

Group (5) x Site (3) for PRE Interval 3

PRE

css/3: general manova	Summary of all Effects; design: 1-GROUP, 2-sitefcp (3)						
Effect	df Effect	MS Effect	df Error	MS Error	F	p-level	GG
1	4	10.55056	45	7.868667	1.34083	.269579	
*2	2	12.14827	90	.787445	15.42745	.000002	.0001
12	8	.90752	90	.787445	1.15248	.336829	.3429

*Marked effects significant at p≤.0500

Group (5) x Site (3) for PRE Interval 4

PRE

css/3: general manova	Summary of all Effects; design: 1-GROUP, 2-sitefcp (4)						
Effect	df Effect	MS Effect	df Error	MS Error	F	p-level	GG.
1	4	6.63423	45	9.020488	.73546	.572660	
*2	2	14.94086	90	.930022	16.06506	.000001	.0001
12	8	1.10203	90	.930022	1.18495	.316974	.3272

*Marked effects significant at p≤.0500

Group (5) x Site (3) for PRE Interval 5

PRE

css/3: general manova	Summary of all Effects; design: 1-GROUP, 2-sitefcp (5)						
Effect	df Effect	MS Effect	df Error	MS Error	F	p-level	GG
1	4	8.79073	45	7.408741	1.18654	.329644	
*2	2	41.65688	90	.546408	76.23776	.000000	.0001
*12	8	1.85703	90	.546408	3.39863	.001870	.0089

*Marked effects significant at p≤.0500

E2 - Two way Anova

Group (5) x Site (3) for PRE Interval 6

PRE

css/3: general manova — Summary of all Effects; design: 1-GROUP, 2-sitefcp (6)

Effect	df Effect	MS Effect	df Error	MS Error	F	p-level	G G.
1	4	.42500	45	7.840444	.05421	.994324	
*2	2	46.85287	90	.602933	77.70820	.000000	.0001
*12	8	2.79045	90	.602933	4.62812	.000093	.0005

*Marked effects significant at p≤.0500

Group (5) x Site (3) for PRE Interval 7

PRE

css/3: general manova — Summary of all Effects; design: 1-GROUP, 2-sitefcp (7)

Effect	df Effect	MS Effect	df Error	MS Error	F	p-level	G G.
1	4	1.79327	45	7.184593	.24960	.908406	
*2	2	16.29086	90	.513592	31.71945	.000000	.0001
12	8	.90187	90	.513592	1.75600	.096373	.1166

*Marked effects significant at p≤.0500

Group (5) x Site (3) for PRE Interval 8

PRE

css/3: general manova — Summary of all Effects; design: 1-GROUP, 2-sitefcp (8)

Effect	df Effect	MS Effect	df Error	MS Error	F	p-level	G G.
1	4	3.730434	45	6.078741	.61369	.654974	
*2	2	9.333264	90	.595230	15.68011	.000001	.0001
*12	8	1.291183	90	.595230	2.16922	.037187	.0649

*Marked effects significant at p≤.0500

Group (5) x Site (3) for PRE Interval 9

PRE

css/3: general manova — Summary of all Effects; design: 1-GROUP, 2-sitefcp (9)

Effect	df Effect	MS Effect	df Error	MS Error	F	p-level	GG
1	4	2.177166	45	6.077029	.358262	.836929	
*2	2	1.971670	90	.440741	4.473533	.014053	.0255
12	8	.765417	90	.440741	1.736658	.100626	.1298

*Marked effects significant at p≤.0500

E3 - Two way Anova

Group (5) x Site (3) for RARE Interval 2

RARE #2

css/3: general manova — Summary of all Effects; design: 1-GROUP, 2-sitefcp (10)

Effect	df Effect	MS Effect	df Error	MS Error	F	p-level	G G
*1	4	21.73907	45	5.165608	4.208424	.005591	
2	2	.60560	90	.255119	2.373797	.098934	·1177
12	8	.51352	90	.255119	2.012852	.053630	·0813

*Marked effects significant at p≤.0500

Group (5) x Site (3) for RARE Interval 3

RARE #3

css/3: general manova — Summary of all Effects; design: 1-GROUP, 2-sitefcp (11)

Effect	df Effect	MS Effect	df Error	MS Error	F	p-level	G G
*1	4	40.93523	45	5.296288	7.729040	.000079	
*2	2	2.05940	90	.437911	4.702780	.011414	·0213
12	8	.79448	90	.437911	1.814258	.084543	·1122

*Marked effects significant at p≤.0500

Group (5) x Site (3) for RARE Interval 4

RARE #4

css/3: general manova — Summary of all Effects; design: 1-GROUP, 2-sitefcp (12)

Effect	df Effect	MS Effect	df Error	MS Error	F	p-level	G G
1	4	6.626067	45	7.033185	.942115	.448422	
*2	2	3.765268	90	.576185	6.534825	.002239	·0037
*12	8	1.550767	90	.576185	2.691439	.010600	·0154

*Marked effects significant at p≤.0500

Group (5) x Site (3) for RARE Interval 5

RARE #5

css/3: general manova — Summary of all Effects; design: 1-GROUP, 2-sitefcp (13)

Effect	df Effect	MS Effect	df Error	MS Error	F	p-level	G G.
1	4	16.88793	45	9.445755	1.78789	.147913	
*2	2	8.41520	90	.757111	11.11489	.000049	·0001
*12	8	5.77953	90	.757111	7.63367	.000000	·0001

*Marked effects significant at p≤.0500

E3 - Two way Anova

Group (5) x Site (3) for RARE Interval 6

RARE #6

css/3: general manova	Summary of all Effects; design: 1-GROUP, 2-sitefcp (14)						
Effect	df Effect	MS Effect	df Error	MS Error	F	p-level	GG.
*1	4	42.87623	45	12.20698	3.51243	.014057	
*2	2	16.14107	90	1.01392	15.91949	.000001	.0001
*12	8	8.31898	90	1.01392	8.20478	.000000	.0001

*Marked effects significant at p≤.0500

Group (5) x Site (3) for RARE Interval 7

RARE # 7

css/3: general manova	Summary of all Effects; design: 1-GROUP, 2-sitefcp (15)						
Effect	df Effect	MS Effect	df Error	MS Error	F	p-level	GG
*1	4	105.7098	45	11.72239	9.01778	.000019	
*2	2	18.3381	90	1.15467	15.88160	.000001	.0001
*12	8	11.6637	90	1.15467	10.10132	.000000	.0001

*Marked effects significant at p≤.0500

Group (5) x Site (3) for RARE Interval 8

RARE #8

css/3: general manova	Summary of all Effects; design: 1-GROUP, 2-sitefcp (16)						
Effect	df Effect	MS Effect	df Error	MS Error	F	p-level	GG
*1	4	97.86256	45	13.71967	7.13301	.000155	
*2	2	29.30480	90	1.24251	23.58515	.000000	.0001
*12	8	16.04472	90	1.24251	12.91314	.000000	.0001

*Marked effects significant at p≤.0500 ✓

Group (5) x Site (3) for RARE Interval 9

RARE # 9

css/3: general manova	Summary of all Effects; design: 1-GROUP, 2-sitefcp (17)						
Effect	df Effect	MS Effect	df Error	MS Error	F	p-level	GG.
*1	4	88.31349	45	13.97080	6.32129	.000400	
*2	2	39.85146	90	1.38853	28.70041	.000000	.0001
*12	8	20.69280	90	1.38853	14.90263	.000000	.0001

*Marked effects significant at p≤.0500

E4 - Fisher LSD post-hoc tests

RARE Interval 3 (Group Matrix)

css/3: general manova			LSD TEST; variable Var.1 Probabilities for Post-Hoc Tests MAIN EFFECT: GROUP			
GROUP	sitefcp		A {1} -.623333	B {2} 1.163333	C {3} -1.17667	D {4} -.980000	E {5} 1.186667
1	....	{1} A		.004309	.356715	.551360	.003869
2	....	{2} B	.004309		.000283	.000773	.968851
3	....	{3} C	.356715	.000283		.742202	.000250
4	....	{4} D	.551360	.000773	.742202		.000687
5	....	{5} E	.003869	.968851	.000258	.000687	

RARE Interval 3 (Site Matrix)

css/3: general manova			LSD TEST; variable Var.1 Probabilities for Post-Hoc Tests MAIN EFFECT: sitefcp		
GROUP	sitefcp		{1} FZ -.132000	{2} CZ .1359999	{3} PZ -.262000
....	1 FZ	{1}		.045837	.328612
....	2 CZ	{2}	* .045837		.003418
....	3 PZ	{3}	.328612	* .003418	

E4 - Fisher LSD post-hoc tests

RARE Interval 4 (Site Matrix)

css/3: general manova — LSD TEST; variable Var.1 — Probabilities for Post-Hoc Tests — MAIN EFFECT: sitefcp

GROUP	sitefcp		{1} -1.08600	{2} -.586000	{3} -.640000
••••	1	{1}		.001415	.004198
••••	2	{2}	.001415		.722898
••••	3	{3}	.004198	.722898	

RARE Interval 4 (Interaction Matrix)

css/3: general manova — LSD TEST; variable Var.1 — Probabilities for Post-Hoc Tests — INTERACTION: 1 x 2

GROUP	sitefcp		{1} -.530000	{2} -.510000	{3} -.790000	{4} -.920000
1	1	{1}		.953149	.445734	.253656
1	2	{2}	.953149		.411651	.230296
1	3	{3}	.445734	.411651		.702657
2	1	{4}	.253656	.230296	.702657	
2	2	{5}	.746661	.702656	.659643	.411652
2	3	{6}	.136505	.121968	.463372	.724543
3	1	{7}	.000092	.000074	.001265	.004100
3	2	{8}	*.025705	*.022199	.136505	.265946
3	3	{9}	.198236	.178787	.597248	.883232
4	1	{10}	.129075	.115176	.445734	.702656
4	2	{11}	.746661	.702656	.659643	.411652
4	3	{12}	.230296	.208532	.659643	.953150
5	1	{13}	.160816	.144266	.518585	.791521
5	2	{14}	*.045039	.051484	.006280	.002011
5	3	{15}	.002203	.002638	.000174	.000043

css/3: general manova — LSD TEST; variable Var.1 — Probabilities for Post-Hoc Tests — INTERACTION: 1 x 2

GROUP	sitefcp		{5} -.640000	{6} -1.04000	{7} -1.92000	{8} -1.30000
1	1	{1}	.746661	.136505	.000092	.025705
1	2	{2}	.702656	.121968	.000074	.022199
1	3	{3}	.659643	.463372	.001265	.136505
2	1	{4}	.411652	.724543	.004100	.265946
2	2	{5}		.241775	.000291	.054991
2	3	{6}	.241775		.011125	.445734
3	1	{7}	.000291	.011125		.071106
3	2	{8}	.054991	.445734	.071106	
3	3	{9}	.333599	.837096	.006280	.333599
4	1	{10}	.230296	.976564	.012042	.463372
4	2	{11}	1.000000	.241774	.000291	.054991
4	3	{12}	.379191	.768993	.004871	.291759
5	1	{13}	.278646	.929776	.008738	.395216
5	2	{14}	.020610	.000646	.000000	.000043
5	3	{15}	.000785	.000011	.000000	.000000

E4 - Fisher LSD post-hoc tests

RARE Interval 4 (Interaction Matrix) - Continued

css/3: general manova

LSD TEST; variable Var.1
Probabilities for Post-Hoc Tests
INTERACTION: 1 x 2

GROUP	sitefcp		(9) -.970000	(10) -1.05000	(11) -.640000	(12) -.940000
1	1	(1)	.198236	.129075	.746661	.230296
1	2	(2)	.178787	.115176	.702656	.208532
1	3	(3)	.597248	.445734	.659643	.659643
2	1	(4)	.883232	.702656	.411652	.953150
2	2	(5)	.333599	.230296	1.000000	.379191
2	3	(6)	.837096	.976564	.241774	.768993
3	1	(7)	.006280	.012042	.000291	.004871
3	2	(8)	.333599	.463372	.054991	.291759
3	3	(9)		.814228	.333598	.929775
4	1	(10)	.814228		.230296	.746660
4	2	(11)	.333598	.230296		.379190
4	3	(12)	.929775	.746660	.379190	
5	1	(13)	.906463	.906463	.278646	.837095
5	2	(14)	.001265	.000586	.020610	.001674
5	3	(15)	.000025	.000010	.000785	.000035

css/3: general manova

LSD TEST; variable Var.1
Probabilities for Post-Hoc Tests
INTERACTION: 1 x 2

GROUP	sitefcp		(13) -1.01000	(14) .1600000	(15) .5400000
1	1	(1)	.160816	.045039	.002203
1	2	(2)	.144266	.051484	.002638
1	3	(3)	.518585	.006280	.000174
2	1	(4)	.791521	.002011	.000043
2	2	(5)	.278646	.020610	.000785
2	3	(6)	.929776	.000646	.000011
3	1	(7)	.008738	.000000	.000000
3	2	(8)	.395216	.000043	.000000
3	3	(9)	.906463	.001265	.000025
4	1	(10)	.906463	.000586	.000010
4	2	(11)	.278646	.020610	.000785
4	3	(12)	.837095	.001674	.000035
5	1	(13)		.000865	.000016
5	2	(14)	.000865		.265946
5	3	(15)	.000016	.265946	

E5 - Fisher LSD post-hoc tests

RARE Interval 6 (Group Matrix)

css/3: general manova

LSD TEST; variable Var.1
Probabilities for Post-Hoc Tests
MAIN EFFECT: GROUP

GROUP	sitefcp		{1} -.450000	{2} -1.87667	{3} .7966666	{4} -.686667	{5} -2.18000
1	....	{1}		.120772	.173810	.794250	.061505
2	....	{2}	.120772		.004849	.193798	.738246
3	....	{3}	.173810	.004849		.107084	.001899
4	....	{4}	.794250	.193798	.107084		.104806
5	....	{5}	.061505	.738246	.001899	.104806	

RARE Interval 6 (Site Matrix)

css/3: general manova

LSD TEST; variable Var.1
Probabilities for Post-Hoc Tests
MAIN EFFECT: sitefcp

GROUP	sitefcp		{1} -1.47400	{2} -.822000	{3} -.342000
....	1 Fz	{1}		.001689	.000000
....	2 C	{2}	.001689		.019252
....	3 ?	{3}	.000000	.019252	

RARE Interval 6 (Interaction Matrix)

css/3: general manova

LSD TEST; variable Var.1
Probabilities for Post-Hoc Tests
INTERACTION: 1 x 2

GROUP	sitefcp		{1} -.330000	{2} -.380000	{3} -.640000	{4} -2.10000
1	1	{1}		.911837	.492967	.000166
1	2	{2}	.911837		.565129	.000245
1	3	{3}	.492967	.565129		.001664
2	1	{4}	.000166	.000245	.001664	
2	2	{5}	.000154	.000227	.001552	.982332
2	3	{6}	.017507	.023205	.086678	.134533
3	1	{7}	.225137	.269813	.595375	.008074
3	2	{8}	.000309	.000210	.000025	.000000
3	3	{9}	.000003	.000002	.000000	.000000
4	1	{10}	.479161	.550293	.982332	.001784
4	2	{11}	.929417	.842041	.439059	.000121
4	3	{12}	.082778	.103812	.289311	.032155
5	1	{13}	.000000	.000000	.000000	.004566
5	2	{14}	.000001	.000002	.000017	.193464
5	3	{15}	.807575	.894301	.658012	.000389

E5 - Fisher LSD post-hoc tests

RARE Interval 6 (Interaction Matrix) - Continued

css/3: general manova

LSD TEST; variable Var.1
Probabilities for Post-Hoc Tests
INTERACTION: 1 x 2

GROUP	sitefcp		{5} -2.11000	{6} -1.42000	{7} -.880000	{8} 1.360000
1	1	{1}	.000154	.017507	.225137	.000309
1	2	{2}	.000227	.023205	.269813	.000210
1	3	{3}	.001552	.086678	.595375	.000025
2	1	{4}	.982332	.134533	.008074	.000000
2	2	{5}		.128966	.007589	.000000
2	3	{6}	.128966		.233614	.000000
3	1	{7}	.007589	.233614		.000003
3	2	{8}	.000000	.000000	.000003	
3	3	{9}	.000000	.000000	.000000	.225137
4	1	{10}	.001664	.090727	.610774	.000023
4	2	{11}	.000112	.013884	.193464	.000419
4	3	{12}	.030481	.506987	.595375	.000000
5	1	{13}	.004871	.000028	.000000	.000000
5	2	{14}	.201052	.005902	.000121	.000000
5	3	{15}	.000360	.032155	.331142	.000131

css/3: general manova

LSD TEST; variable Var.1
Probabilities for Post-Hoc Tests
INTERACTION: 1 x 2

GROUP	sitefcp		{9} 1.910000	{10} -.650000	{11} -.290000	{12} -1.12000
1	1	{1}	.000003	.479161	.929417	.082778
1	2	{2}	.000002	.550293	.842041	.103812
1	3	{3}	.000000	.982332	.439059	.289311
2	1	{4}	.000000	.001784	.000121	.032155
2	2	{5}	.000000	.001664	.000112	.030481
2	3	{6}	.000000	.090727	.013884	.506987
3	1	{7}	.000000	.610774	.193464	.595375
3	2	{8}	.225137	.000023	.000419	.000000
3	3	{9}		.000000	.000004	.000000
4	1	{10}	.000000		.426140	.299413
4	2	{11}	.000004	.426140		.068598
4	3	{12}	.000000	.299413	.068598	
5	1	{13}	.000000	.000000	.000000	.000002
5	2	{14}	.000000	.000018	.000001	.000759
5	3	{15}	.000001	.642099	.739834	.134533

css/3: general manova

LSD TEST; variable Var.1
Probabilities for Post-Hoc Tests
INTERACTION: 1 x 2

GROUP	sitefcp		{13} -3.41000	{14} -2.69000	{15} -.440000
1	1	{1}	.000000	.000001	.807575
1	2	{2}	.000000	.000002	.894301
1	3	{3}	.000000	.000017	.658012
2	1	{4}	.004566	.193464	.000389
2	2	{5}	.004871	.201052	.000360
2	3	{6}	.000028	.005902	.032155
3	1	{7}	.000000	.000121	.331142
3	2	{8}	.000000	.000000	.000131
3	3	{9}	.000000	.000000	.000001
4	1	{10}	.000000	.000018	.642099
4	2	{11}	.000000	.000001	.739834
4	3	{12}	.000002	.000759	.134533
5	1	{13}		.113352	.000000
5	2	{14}	.113352		.000003
5	3	{15}	.000000	.000003	

E5 - Fisher LSD post-hoc tests

RARE Interval 7 (Group Matrix)

css/3: general manova — LSD TEST; variable Var.1, Probabilities for Post-Hoc Tests, MAIN EFFECT: GROUP

GROUP	sitefcp		{1} -.266667	{2} -1.64333	{3} 2.730000	{4} -.193333	{5} -2.06000
1	••••	{1}		.126410	.001464	.934256	.048440
2	••••	{2}	.126410		.000011	.107930	.639681
3	••••	{3}	.001464	.000011		.001860	.000002
4	••••	{4}	.934256	.107930	.001860		.040310
5	••••	{5}	.048440	.639681	.000002	.040310	

RARE Interval 7 (Site Matrix)

css/3: general manova — LSD TEST; variable Var.1, Probabilities for Post-Hoc Tests, MAIN EFFECT: sitefcp

GROUP	sitefcp		{1} -.954000	{2} -.134000	{3} .2280001
••••	1	{1}		.000249	.000000
••••	2	{2}	.000249		.095567
••••	3	{3}	.000000	.095567	

RARE Interval 7 (Interaction Matrix)

css/3: general manova — LSD TEST; variable Var.1, Probabilities for Post-Hoc Tests, INTERACTION: 1 x 2

GROUP	sitefcp		{1} -.060000	{2} -.110000	{3} -.630000	{4} -1.75000
1	1	{1}		.917364	.238695	.000687
1	2	{2}	.917364		.282109	.000966
1	3	{3}	.238695	.282109		.022008
2	1	{4}	.000687	.000966	.022008	
2	2	{5}	.000421	.000598	.015145	.884512
2	3	{6}	.008164	.010862	.132250	.419186
3	1	{7}	.547716	.481076	.076883	.000084
3	2	{8}	.000000	.000000	.000000	.000000
3	3	{9}	.000000	.000000	.000000	.000000
4	1	{10}	.771470	.851860	.373283	.001754
4	2	{11}	.618702	.547716	.095348	.000122
4	3	{12}	.300913	.351566	.884512	.015145
5	1	{13}	.000000	.000000	.000004	.011489
5	2	{14}	.000008	.000013	.000641	.230620
5	3	{15}	.099443	.122107	.633376	.067302

E5 - Fisher LSD post-hoc tests

RARE Interval 7 (Interaction Matrix) - Continued

css/3: general manova — LSD TEST; variable Var.1 — Probabilities for Post-Hoc Tests — INTERACTION: 1 x 2

GROUP	sitefcp		(5) -1.82000	(6) -1.36000	(7) .2300000	(8) 3.410000
1	1	(1)	.000421	.008164	.547716	.000000
1	2	(2)	.000598	.010862	.481076	.000000
1	3	(3)	.015145	.132250	.076883	.000000
2	1	(4)	.884512	.419186	.000084	.000000
2	2	(5)		.341019	.000049	.000000
2	3	(6)	.341019		.001349	.000000
3	1	(7)	.000049	.001349		.000000
3	2	(8)	.000000	.000000	.000000	
3	3	(9)	.000000	.000000	.000000	.019810
4	1	(10)	.001105	.017810	.373283	.000000
4	2	(11)	.000072	.001872	.917364	.000000
4	3	(12)	.010265	.099443	.103680	.000000
5	1	(13)	.016878	.001033	.000000	.000000
5	2	(14)	.291407	.046517	.000001	.000000
5	3	(15)	.048770	.300913	.025709	.000000

css/3: general manova — LSD TEST; variable Var.1 — Probabilities for Post-Hoc Tests — INTERACTION: 1 x 2

GROUP	sitefcp		(9) 4.550000	(10) -.200000	(11) .1800000	(12) -.560000
1	1	(1)	.000000	.771470	.618702	.300913
1	2	(2)	.000000	.851860	.547716	.351566
1	3	(3)	.000000	.373283	.095348	.884512
2	1	(4)	.000000	.001754	.000122	.015145
2	2	(5)	.000000	.001105	.000072	.010265
2	3	(6)	.000000	.017810	.001872	.099443
3	1	(7)	.000000	.373283	.917364	.103680
3	2	(8)	.019810	.000000	.000000	.000000
3	3	(9)		.000000	.000000	.000000
4	1	(10)	.000000		.431169	.455732
4	2	(11)	.000000	.431169		.127098
4	3	(12)	.000000	.455732	.127098	
5	1	(13)	.000000	.000000	.000000	.000002
5	2	(14)	.000000	.000026	.000001	.000393
5	3	(15)	.000000	.173038	.033100	.534026

css/3: general manova — LSD TEST; variable Var.1 — Probabilities for Post-Hoc Tests — INTERACTION: 1 x 2

GROUP	sitefcp		(13) -2.99000	(14) -2.33000	(15) -.860000
1	1	(1)	.000000	.000008	.099443
1	2	(2)	.000000	.000013	.122107
1	3	(3)	.000004	.000641	.633376
2	1	(4)	.011489	.230620	.067302
2	2	(5)	.016878	.291407	.048770
2	3	(6)	.001033	.046517	.300913
3	1	(7)	.000000	.000001	.025709
3	2	(8)	.000000	.000000	.000000
3	3	(9)	.000000	.000000	.000000
4	1	(10)	.000000	.000026	.173038
4	2	(11)	.000000	.000001	.033100
4	3	(12)	.000002	.000393	.534026
5	1	(13)		.173038	.000026
5	2	(14)	.173038		.002926
5	3	(15)	.000026	.002926	

E5 - Fisher LSD post-hoc tests

RARE Interval 8 (Group Matrix)

css/3: general manova — LSD TEST; variable Var.1 — Probabilities for Post-Hoc Tests — MAIN EFFECT: GROUP

GROUP	sitefcp		{1} -.163333	{2} -1.13667	{3} 3.173333	{4} .0733333	{5} -1.31667
1	....	{1}		.314244	.001097	.805675	.234140
2	....	{2}	.314244		.000047	.212312	.851557
3	....	{3}	.001097	.000047		.002242	.000025
4	....	{4}	.805675	.212312	.002242		.153048
5	....	{5}	.234140	.851557	.000025	.153048	

RARE Interval 8 (Site Matrix)

css/3: general manova — LSD TEST; variable Var.1 — Probabilities for Post-Hoc Tests — MAIN EFFECT: sitefcp

GROUP	sitefcp		{1} -.694000	{2} .2500000	{3} .8219999
....	1	{1}		.000055	.000000
....	2	{2}	.000055		.011948
....	3	{3}	.000000	.011948	

RARE Interval 8 (Interaction Matrix)

css/3: general manova — LSD TEST; variable Var.1 — Probabilities for Post-Hoc Tests — INTERACTION: 1 x 2

GROUP	sitefcp		{1} -.000000	{2} -.040000	{3} -.450000	{4} -1.16000
1	1	{1}		.936224	.369091	.022211
1	2	{2}	.936224		.412985	.027102
1	3	{3}	.369091	.412985		.157826
2	1	{4}	.022211	.027102	.157826	
2	2	{5}	.019071	.023354	.141183	.952145
2	3	{6}	.036209	.043661	.224270	.841463
3	1	{7}	.888641	.825855	.299682	.015502
3	2	{8}	.000000	.000000	.000000	.000000
3	3	{9}	.000000	.000000	.000000	.000000
4	1	{10}	.631369	.689221	.674567	.068248
4	2	{11}	.509672	.459883	.121164	.003609
4	3	{12}	.794856	.733881	.247706	.011262
5	1	{13}	.000044	.000060	.001039	.052393
5	2	{14}	.002511	.003201	.029885	.436064
5	3	{15}	.603255	.660037	.703995	.074353

E5 - Fisher LSD post-hoc tests

RARE Interval 8 (Interaction Matrix) - Continued

css/3: general manova

LSD TEST; variable Var.1
Probabilities for Post-Hoc Tests
INTERACTION: 1 x 2

GROUP	sitefcp		{5} -1.19000	{6} -1.06000	{7} .0700000	{8} 3.700000
1	1	{1}	.019071	.036209	.888641	.000000
1	2	{2}	.023354	.043661	.825855	.000000
1	3	{3}	.141183	.224270	.299682	.000000
2	1	{4}	.952145	.841463	.015502	.000000
2	2	{5}		.794856	.013230	.000000
2	3	{6}	.794856		.025798	.000000
3	1	{7}	.013230	.025798		.000000
3	2	{8}	.000000	.000000	.000000	
3	3	{9}	.000000	.000000	.000000	.000086
4	1	{10}	.059879	.103472	.535602	.000000
4	2	{11}	.003014	.006464	.603255	.000000
4	3	{12}	.009562	.019071	.904465	.000000
5	1	{13}	.059879	.032915	.000026	.000000
5	2	{14}	.472065	.328268	.001625	.000000
5	3	{15}	.065355	.112038	.509672	.000000

css/3: general manova

LSD TEST; variable Var.1
Probabilities for Post-Hoc Tests
INTERACTION: 1 x 2

GROUP	sitefcp		{9} 5.750000	{10} -.240000	{11} .3300000	{12} .1300000
1	1	{1}	.000000	.631369	.509672	.794856
1	2	{2}	.000000	.689221	.459883	.733881
1	3	{3}	.000000	.674567	.121164	.247706
2	1	{4}	.000000	.068248	.003609	.011262
2	2	{5}	.000000	.059879	.003014	.009562
2	3	{6}	.000000	.103472	.006464	.019071
3	1	{7}	.000000	.535602	.603255	.904465
3	2	{8}	.000086	.000000	.000000	.000000
3	3	{9}		.000000	.000000	.000000
4	1	{10}	.000000		.255892	.459883
4	2	{11}	.000000	.255892		.689221
4	3	{12}	.000000	.459883	.689221	
5	1	{13}	.000000	.000252	.000003	.000016
5	2	{14}	.000000	.010101	.000290	.001108
5	3	{15}	.000000	.968086	.239708	.436064

css/3: general manova

LSD TEST; variable Var.1
Probabilities for Post-Hoc Tests
INTERACTION: 1 x 2

GROUP	sitefcp		{13} -2.14000	{14} -1.55000	{15} -.260000
1	1	{1}	.000044	.002511	.603255
1	2	{2}	.000060	.003201	.660037
1	3	{3}	.001039	.029885	.703995
2	1	{4}	.052393	.436064	.074353
2	2	{5}	.059879	.472065	.065355
2	3	{6}	.032915	.328268	.112038
3	1	{7}	.000026	.001625	.509672
3	2	{8}	.000000	.000000	.000000
3	3	{9}	.000000	.000000	.000000
4	1	{10}	.000252	.010101	.968086
4	2	{11}	.000003	.000290	.239708
4	3	{12}	.000016	.001108	.436064
5	1	{13}		.239708	.000290
5	2	{14}	.239708		.011262
5	3	{15}	.000290	.011262	

E5 - Fisher LSD post-hoc tests

RARE Interval 9 (Group Matrix)

css/3: general manova			LSD TEST; variable Var.1 Probabilities for Post-Hoc Tests MAIN EFFECT: GROUP				
GROUP	sitefcp		{1} -.123333	{2} -1.40667	{3} 2.856667	{4} .0133334	{5} -1.27333
1	....	{1}		.190298	.003448	.888019	.239662
2	....	{2}	.190298		.000062	.148149	.890733
3	....	{3}	.003448	.000062		.005080	.000097
4	....	{4}	.888019	.148149	.005080		.189171
5	....	{5}	.239662	.890733	.000097	.189171	

RARE Interval 9 (Site Matrix)

css/3: general manova			LSD TEST; variable Var.1 Probabilities for Post-Hoc Tests MAIN EFFECT: sitefcp		
GROUP	sitefcp		{1} -.936000	{2} .1400000	{3} .8360000
....	1	{1}		.000016	.000000
....	2	{2}	.000016		.004011
....	3	{3}	.000000	.004011	

RARE Interval 9 (Interaction Matrix)

css/3: general manova			LSD TEST; variable Var.1 Probabilities for Post-Hoc Tests INTERACTION: 1 x 2			
GROUP	sitefcp		{1} -.090000	{2} .0300000	{3} -.310000	{4} -1.36000
1	1	{1}		.820386	.677326	.017989
1	2	{2}	.820386		.520447	.009834
1	3	{3}	.677326	.520447		.049347
2	1	{4}	.017989	.009834	.049347	
2	2	{5}	.009336	.004907	.027609	.805711
2	3	{6}	.017131	.009336	.047267	.984902
3	1	{7}	.175256	.114444	.345261	.299426
3	2	{8}	.000000	.000000	.000000	.000000
3	3	{9}	.000000	.000000	.000000	.000000
4	1	{10}	.299426	.206863	.532762	.175255
4	2	{11}	.733471	.909605	.449810	.007172
4	3	{12}	.200226	.290779	.091112	.000370
5	1	{13}	.001858	.000899	.006443	.427551
5	2	{14}	.012077	.006443	.034704	.879678
5	3	{15}	.335747	.235035	.583472	.152722

E5 - Fisher LSD post-hoc tests

RARE Interval 9 (Interaction Matrix) - Continued

css/3: general manova — LSD TEST; variable Var.1 — Probabilities for Post-Hoc Tests — INTERACTION: 1 x 2

GROUP	sitefcp		{5} -1.49000	{6} -1.37000	{7} -.810000	{8} 3.510000
1	1	{1}	.009336	.017131	.175256	.000000
1	2	{2}	.004907	.009336	.114444	.000000
1	3	{3}	.027609	.047267	.345261	.000000
2	1	{4}	.805711	.984902	.299426	.000000
2	2	{5}		.820386	.200226	.000000
2	3	{6}	.820386		.290779	.000000
3	1	{7}	.200226	.290779		.000000
3	2	{8}	.000000	.000000	.000000	
3	3	{9}	.000000	.000000	.000000	.000022
4	1	{10}	.110253	.169398	.747751	.000000
4	2	{11}	.003510	.006799	.091112	.000000
4	3	{12}	.000157	.000347	.009336	.000000
5	1	{13}	.583472	.438598	.068963	.000000
5	2	{14}	.924621	.894622	.235035	.000000
5	3	{15}	.094706	.147454	.691207	.000000

css/3: general manova — LSD TEST; variable Var.1 — Probabilities for Post-Hoc Tests — INTERACTION: 1 x 2

GROUP	sitefcp		{9} 5.870000	{10} -.640000	{11} .0900001	{12} .5899999
1	1	{1}	.000000	.299426	.733471	.200226
1	2	{2}	.000000	.206863	.909605	.290779
1	3	{3}	.000000	.532762	.449810	.091112
2	1	{4}	.000000	.175255	.007172	.000370
2	2	{5}	.000000	.110253	.003510	.000157
2	3	{6}	.000000	.169398	.006799	.000347
3	1	{7}	.000000	.747751	.091112	.009336
3	2	{8}	.000022	.000000	.000000	.000000
3	3	{9}		.000000	.000000	.000000
4	1	{10}	.000000		.169398	.021819
4	2	{11}	.000000	.169398		.345261
4	3	{12}	.000000	.021819	.345261	
5	1	{13}	.000000	.033170	.000618	.000020
5	2	{14}	.000000	.132497	.004643	.000219
5	3	{15}	.000000	.939664	.193748	.026353

css/3: general manova — LSD TEST; variable Var.1 — Probabilities for Post-Hoc Tests — INTERACTION: 1 x 2

GROUP	sitefcp		{13} -1.78000	{14} -1.44000	{15} -.600000
1	1	{1}	.001858	.012077	.335747
1	2	{2}	.000899	.006443	.235035
1	3	{3}	.006443	.034704	.583472
2	1	{4}	.427551	.879678	.152722
2	2	{5}	.583472	.924621	.094706
2	3	{6}	.438598	.894622	.147454
3	1	{7}	.068963	.235035	.691207
3	2	{8}	.000000	.000000	.000000
3	3	{9}	.000000	.000000	.000000
4	1	{10}	.033170	.132497	.939664
4	2	{11}	.000618	.004643	.193748
4	3	{12}	.000020	.000219	.026353
5	1	{13}		.520447	.027609
5	2	{14}	.520447		.114444
5	3	{15}	.027609	.114444	

E6 - Two way Anova

Group (5) x Site (3) for POST Interval 2

Post #2

css/3: general manova	Summary of all Effects; design: 1-GROUP, 2-sitefcp (18)						
Effect	df Effect	MS Effect	df Error	MS Error	F	p-level	GG.
*1	4	37.14277	45	12.48858	2.97414	.029112	
*2	2	15.23168	90	.87671	17.37366	.000000	.0001
12	8	1.42742	90	.87671	1.62815	.127833	.1635

*Marked effects significant at p≤.0500

Group (5) x Site (3) for POST Interval 3

Post #3

css/3: general manova	Summary of all Effects; design: 1-GROUP, 2-sitefcp (19)						
Effect	df Effect	MS Effect	df Error	MS Error	F	p-level	GG
1	4	12.79906	45	9.138133	1.40062	.249102	
*2	2	14.07646	90	1.213311	11.60170	.000033	.0004
12	8	1.46697	90	1.213311	1.20906	.302807	.3151

*Marked effects significant at p≤.0500

Group (5) x Site (3) for POST Interval 4

Post #4

css/3: general manova	Summary of all Effects; design: 1-GROUP, 2-sitefcp (20)						
Effect	df Effect	MS Effect	df Error	MS Error	F	p-level	GG
*1	4	43.21839	45	12.46336	3.46764	.014928	
*2	2	39.21168	90	1.32996	29.48345	.000000	.0001
*12	8	4.90175	90	1.32996	3.68565	.000923	.0022

*Marked effects significant at p≤.0500

Group (5) x Site (3) for POST Interval 5

Post #5

css/3: general manova	Summary of all Effects; design: 1-GROUP, 2-sitefcp (21)						
Effect	df Effect	MS Effect	df Error	MS Error	F	p-level	GG
1	4	22.71840	45	13.97636	1.62549	.184350	
*2	2	70.74021	90	.83230	84.99406	.000000	.0001
*12	8	4.07745	90	.83230	4.89904	.000048	.0002

*Marked effects significant at p≤.0500

E6 - Two way Anova

Group (5) x Site (3) for POST Interval 6

POST #6.

css/3: general manova	Summary of all Effects; design: 1-GROUP, 2-sitefcp (22).						
Effect	df Effect	MS Effect	df Error	MS Error	F	p-level	G G
1	4	3.95383	45	10.23940	.38614	.817405	
*2	2	77.48660	90	1.00676	76.96661	.000000	.0001
*12	8	2.85818	90	1.00676	2.83900	.007394	.0143

*Marked effects significant at p≤.0500

Group (5) x Site (3) for POST Interval 7

POST #7

css/3: general manova	Summary of all Effects; design: 1-GROUP, 2-sitefcp (23)						
Effect	df Effect	MS Effect	df Error	MS Error	F	p-level	G G
1	4	1.88133	45	7.381696	.25486	.905183	
*2	2	38.53040	90	.703319	54.78369	.000000	.0001
*12	8	1.65173	90	.703319	2.34848	.024282	.0357

*Marked effects significant at p≤.0500

Group (5) x Site (3) for POST Interval 8

POST #8.

css/3: general manova	Summary of all Effects; design: 1-GROUP, 2-sitefcp (24)						
Effect	df Effect	MS Effect	df Error	MS Error	F	p-level	G G.
1	4	6.13650	45	7.668756	.80020	.531474	
*2	2	25.16541	90	.568511	44.26548	.000000	.0001
12	8	.71290	90	.568511	1.25398	.277707	.2936

*Marked effects significant at p≤.0500

Group (5) x Site (3) for POST Interval 9

POST #9.

css/3: general manova	Summary of all Effects; design: 1-GROUP, 2-sitefcp (25).						
Effect	df Effect	MS Effect	df Error	MS Error	F	p-level	G G.
1	4	4.50543	45	8.345022	.53989	.707176	
*2	2	15.98586	90	.558711	28.61204	.000000	.0001
12	8	1.14053	90	.558711	2.04137	.050189	.0771

*Marked effects significant at p≤.0500

E7 - Fisher LSD post-hoc tests

POST Interval 2 (Group Matrix)

css/3: general manova			LSD TEST; variable Var.1 Probabilities for Post-Hoc Tests MAIN EFFECT: GROUP				
GROUP	sitefcp		{1} -4.18000	{2} -1.43667	{3} -3.14667	{4} -3.71667	{5} -2.22667
1	....	{1}		.004312	.263432	.614082	.037748
2	....	{2}	.004312		.067422	.016182	.391194
3	....	{3}	.263432	.067422		.535330	.318716
4	....	{4}	.614082	.016182	.535330		.109456
5	....	{5}	.037748	.391194	.318716	.109456	

POST Interval 2 (Site Matrix)

css/3: general manova			LSD TEST; variable Var.1 Probabilities for Post-Hoc Tests MAIN EFFECT: sitefcp		
GROUP	sitefcp		{1} -3.13800	{2} -3.36800	{3} -2.31800
....	1	FZ {1}		.222574	.000032
....	2	CZ {2}	.222574		.000000
....	3	PZ {3}	.000032	.000000	

E7 - Fisher LSD post-hoc tests

POST Interval 4 (Group Matrix)

css/3: general manova — LSD TEST; variable Var.1 — Probabilities for Post-Hoc Tests — MAIN EFFECT: GROUP

GROUP	sitefcp		{1} 1.020000	{2} -.740000	{3} 1.263333	{4} 2.300000	{5} -.146667
1	....	{1}		.059821	.790727	.167115	.207141
2	....	{2}	.059821		.033153	.001715	.518409
3	....	{3}	.790727	.033153		.261441	.128905
4	....	{4}	.167115	.001715	.261441		.010141
5	....	{5}	.207141	.518409	.128905	.010141	

POST Interval 4 (Site Matrix)

css/3: general manova — LSD TEST; variable Var.1 — Probabilities for Post-Hoc Tests — MAIN EFFECT: sitefcp

GROUP	sitefcp		{1} -.164000	{2} 1.606000	{3} .7759999
....	1	{1}		.000000	.000099
....	2	{2}	.000000		.000523
....	3	{3}	.000099	.000523	

POST Interval 4 (Interaction Matrix)

css/3: general manova — LSD TEST; variable Var.1 — Probabilities for Post-Hoc Tests — INTERACTION: 1 x 2

GROUP	sitefcp		{1} .0499999	{2} 2.200000	{3} .8099999	{4} -.810000
1	1	{1}		.000070	.144078	.098892
1	2	{2}	.000070		.008396	.000000
1	3	{3}	.144078	.008396		.002278
2	1	{4}	.098892	.000000	.002278	
2	2	{5}	.197229	.000000	.006757	.713440
2	3	{6}	.106869	.000000	.002565	.969153
3	1	{7}	.562233	.000543	.374816	.026941
3	2	{8}	.000014	.670712	.002418	.000000
3	3	{9}	.063235	.024482	.684843	.000619
4	1	{10}	.325381	.002021	.629040	.009344
4	2	{11}	.000000	.000660	.000000	.000000
4	3	{12}	.000029	.816544	.004323	.000000
5	1	{13}	.051019	.000000	.000852	.757102
5	2	{14}	.938352	.000053	.124373	.115355
5	3	{15}	.364569	.001586	.575313	.011537

E7 - Fisher LSD post-hoc tests

POST Interval 4 (Interaction Matrix) - Continued

css/3: general manova — LSD TEST; variable Var.1 — Probabilities for Post-Hoc Tests — INTERACTION: 1 x 2

GROUP	sitefcp		(5) -.620000	(6) -.790000	(7) .3500001	(8) 2.420000
1	1	(1)	.197229	.106869	.562233	.000014
1	2	(2)	.000000	.000000	.000543	.670712
1	3	(3)	.006757	.002565	.374816	.002418
2	1	(4)	.713440	.969153	.026941	.000000
2	2	(5)		.742452	.063235	.000000
2	3	(6)	.742452		.029613	.000000
3	1	(7)	.063235	.029613		.000124
3	2	(8)	.000000	.000000	.000124	
3	3	(9)	.002021	.000703	.197229	.007955
4	1	(10)	.024482	.010388	.684844	.000509
4	2	(11)	.000000	.000000	.000000	.002565
4	3	(12)	.000000	.000000	.000245	.846695
5	1	(13)	.499112	.727896	.012153	.000000
5	2	(14)	.225073	.124373	.511423	.000010
5	3	(15)	.029613	.012799	.742452	.000392

css/3: general manova — LSD TEST; variable Var.1 — Probabilities for Post-Hoc Tests — INTERACTION: 1 x 2

GROUP	sitefcp		(9) 1.020000	(10) .5599999	(11) 4.020000	(12) 2.320000
1	1	(1)	.063235	.325381	.000000	.000029
1	2	(2)	.024482	.002021	.000660	.816544
1	3	(3)	.684843	.629040	.000000	.004323
2	1	(4)	.000619	.009344	.000000	.000000
2	2	(5)	.002021	.024482	.000000	.000000
2	3	(6)	.000703	.010388	.000000	.000000
3	1	(7)	.197229	.684844	.000000	.000245
3	2	(8)	.007955	.000509	.002565	.846695
3	3	(9)		.374816	.000000	.013476
4	1	(10)	.374816		.000000	.000966
4	2	(11)	.000000	.000000		.001403
4	3	(12)	.013476	.000966	.001403	
5	1	(13)	.000214	.003856	.000000	.000000
5	2	(14)	.053287	.289085	.000000	.000022
5	3	(15)	.334907	.938352	.000000	.000750

css/3: general manova — LSD TEST; variable Var.1 — Probabilities for Post-Hoc Tests — INTERACTION: 1 x 2

GROUP	sitefcp		(13) -.970000	(14) .0100000	(15) .5200000
1	1	(1)	.051019	.938352	.364569
1	2	(2)	.000000	.000053	.001586
1	3	(3)	.000852	.124373	.575313
2	1	(4)	.757102	.115355	.011537
2	2	(5)	.499112	.225073	.029613
2	3	(6)	.727896	.124373	.012799
3	1	(7)	.012153	.511423	.742452
3	2	(8)	.000000	.000010	.000392
3	3	(9)	.000214	.053287	.334907
4	1	(10)	.003856	.289085	.938352
4	2	(11)	.000000	.000000	.000000
4	3	(12)	.000000	.000022	.000750
5	1	(13)		.060612	.004841
5	2	(14)	.060612		.325381
5	3	(15)	.004841	.325381	

E8 - Fisher LSD post-hoc tests

POST Interval 5 (Site Matrix)

css/3: general manova — LSD TEST; variable Var.1 — Probabilities for Post-Hoc Tests — MAIN EFFECT: sitefcp

GROUP	sitefcp		{1} -2.67400	{2} -1.42800	{3} -.296000
••••	1	{1}		.000000	.000000
••••	2	{2}	.000000		.000000
••••	3	{3}	.000000	.000000	

POST Interval 5 (Interaction Matrix)

css/3: general manova — LSD TEST; variable Var.1 — Probabilities for Post-Hoc Tests — INTERACTION: 1 x 2

GROUP	sitefcp		{1} -3.41000	{2} -2.26000	{3} -1.30000	{4} -2.23000
1	1	{1}		.005929	.000001	.004796
1	2	{2}	.005929		.020803	.941547
1	3	{3}	.000001	.020803		.025005
2	1	{4}	.004796	.941547	.025005	
2	2	{5}	.002677	.788076	.040054	.844989
2	3	{6}	.000003	.029937	.883413	.035699
3	1	{7}	.000003	.031760	.864159	.037822
3	2	{8}	.000000	.000000	.000774	.000000
3	3	{9}	.000000	.000000	.000037	.000000
4	1	{10}	.165825	.158602	.000287	.138382
4	2	{11}	.000000	.000065	.069322	.000085
4	3	{12}	.000000	.000000	.000001	.000000
5	1	{13}	.788076	.002677	.000000	.002137
5	2	{14}	.007821	.922119	.016178	.864160
5	3	{15}	.000000	.000001	.004796	.000001

css/3: general manova — LSD TEST; variable Var.1 — Probabilities for Post-Hoc Tests — INTERACTION: 1 x 2

GROUP	sitefcp		{5} -2.15000	{6} -1.36000	{7} -1.37000	{8} .1200000
1	1	{1}	.002677	.000003	.000003	.000000
1	2	{2}	.788076	.029937	.031760	.000000
1	3	{3}	.040054	.883413	.864159	.000774
2	1	{4}	.844989	.035699	.037822	.000000
2	2	{5}		.055968	.059084	.000000
2	3	{6}	.055968		.980500	.000474
3	1	{7}	.059084	.980500		.000437
3	2	{8}	.000000	.000474	.000437	
3	3	{9}	.000000	.000021	.000020	.393251
4	1	{10}	.094259	.000474	.000515	.000000
4	2	{11}	.000171	.050153	.047443	.104042
4	3	{12}	.000000	.000001	.000001	.085238
5	1	{13}	.001153	.000001	.000001	.000000
5	2	{14}	.713996	.023528	.025005	.000000
5	3	{15}	.000003	.003105	.002884	.557842

E8 - Fisher LSD post-hoc tests

POST Interval 5 (Interaction Matrix) - Continued

css/3: general manova — LSD TEST; variable Var.1 — Probabilities for Post-Hoc Tests — INTERACTION: 1 x 2

GROUP	sitefcp		{9} .4700000	{10} -2.84000	{11} -.550000	{12} .8300001
1	1	{1}	.000000	.165825	.000000	.000000
1	2	{2}	.000000	.158602	.000065	.000000
1	3	{3}	.000037	.000287	.069322	.000001
2	1	{4}	.000000	.138382	.000085	.000000
2	2	{5}	.000000	.094259	.000171	.000000
2	3	{6}	.000021	.000474	.050153	.000001
3	1	{7}	.000020	.000515	.047443	.000001
3	2	{8}	.393251	.000000	.104042	.085238
3	3	{9}		.000000	.014230	.379930
4	1	{10}	.000000		.000000	.000000
4	2	{11}	.014230	.000000		.001065
4	3	{12}	.379930	.000000	.001065	
5	1	{13}	.000000	.099052	.000000	.000000
5	2	{14}	.000000	.189005	.000045	.000000
5	3	{15}	.151623	.000000	.294733	.022128

css/3: general manova — LSD TEST; variable Var.1 — Probabilities for Post-Hoc Tests — INTERACTION: 1 x 2

GROUP	sitefcp		{13} -3.52000	{14} -2.30000	{15} -.120000
1	1	{1}	.788076	.007821	.000000
1	2	{2}	.002677	.922119	.000001
1	3	{3}	.000000	.016178	.004796
2	1	{4}	.002137	.864160	.000001
2	2	{5}	.001153	.713996	.000003
2	3	{6}	.000001	.023528	.003105
3	1	{7}	.000001	.025005	.002884
3	2	{8}	.000000	.000000	.557842
3	3	{9}	.000000	.000000	.151623
4	1	{10}	.099052	.189005	.000000
4	2	{11}	.000000	.000045	.294733
4	3	{12}	.000000	.000000	.022128
5	1	{13}		.003595	.000000
5	2	{14}	.003595		.000001
5	3	{15}	.000000	.000001	

E8 - Fisher LSD post-hoc tests

POST Interval 6 (Site Matrix)

css/3: general manova — LSD TEST; variable Var.1 — Probabilities for Post-Hoc Tests — MAIN EFFECT: sitefcp

GROUP	sitefcp		{1} Fz -2.81200	{2} Cz -2.47200	{3} Pz -.506000
••••	1 Fz	{1}		.093669	.000000
••••	2 Cz	{2}	.093669		.000000
••••	3 Pz	{3}	.000000	.000000	

POST Interval 6 (Interaction Matrix)

css/3: general manova — LSD TEST; variable Var.1 — Probabilities for Post-Hoc Tests — INTERACTION: 1 x 2

GROUP	sitefcp		{1} -3.22000	{2} -3.25000	{3} -1.20000	{4} -1.98000
1	1	{1}		.946844	.000020	.006936
1	2	{2}	.946844		.000016	.005736
1	3	{3}	.000020	.000016		.085583
2	1	{4}	.006936	.005736	.085583	
2	2	{5}	.033295	.028335	.021496	.548881
2	3	{6}	.000043	.000033	.841488	.127630
3	1	{7}	.249584	.223508	.001210	.112095
3	2	{8}	.026831	.022734	.026831	.609510
3	3	{9}	.000000	.000000	.018134	.000077
4	1	{10}	.964548	.911526	.000024	.007860
4	2	{11}	.024034	.020319	.029911	.640919
4	3	{12}	.000000	.000000	.000907	.000001
5	1	{13}	.563751	.519742	.000171	.031564
5	2	{14}	.093781	.081711	.006113	.287613
5	3	{15}	.000000	.000000	.038995	.000234

css/3: general manova — LSD TEST; variable Var.1 — Probabilities for Post-Hoc Tests — INTERACTION: 1 x 2

GROUP	sitefcp		{5} -2.25000	{6} -1.29000	{7} -2.70000	{8} -2.21000
1	1	{1}	.033295	.000043	.249584	.026831
1	2	{2}	.028335	.000033	.223508	.022734
1	3	{3}	.021496	.841488	.001210	.026831
2	1	{4}	.548881	.127630	.112095	.609510
2	2	{5}		.035109	.318623	.929167
2	3	{6}	.035109		.002270	.043247
3	1	{7}	.318623	.002270		.277752
3	2	{8}	.929167	.043247	.277752	
3	3	{9}	.000008	.010679	.000000	.000011
4	1	{10}	.037008	.000051	.268127	.029911
4	2	{11}	.893928	.047892	.258739	.964548
4	3	{12}	.000000	.000466	.000000	.000000
5	1	{13}	.117096	.000344	.563751	.098114
5	2	{14}	.640919	.010679	.594071	.578816
5	3	{15}	.000026	.024034	.000000	.000036

E8 - Fisher LSD post-hoc tests

POST Interval 6 (Interaction Matrix) - Continued

css/3: general manova — LSD TEST; variable Var.1 — Probabilities for Post-Hoc Tests — INTERACTION: 1 x 2

GROUP	sitefcp		{9} -.120000	{10} -3.20000	{11} -2.19000	{12} .3400001
1	1	{1}	.000000	.964548	.024034	.000000
1	2	{2}	.000000	.911526	.020319	.000000
1	3	{3}	.018134	.000024	.029911	.000907
2	1	{4}	.000077	.007860	.640919	.000001
2	2	{5}	.000008	.037008	.893928	.000000
2	3	{6}	.010679	.000051	.047892	.000466
3	1	{7}	.000000	.268127	.258739	.000000
3	2	{8}	.000011	.029911	.964548	.000000
3	3	{9}		.000000	.000013	.308047
4	1	{10}	.000000		.026831	.000000
4	2	{11}	.000013	.026831		.000000
4	3	{12}	.308047	.000000	.000000	
5	1	{13}	.000000	.594070	.089605	.000000
5	2	{14}	.000001	.102608	.548881	.000000
5	3	{15}	.755764	.000000	.000043	.184550

css/3: general manova — LSD TEST; variable Var.1 — Probabilities for Post-Hoc Tests — INTERACTION: 1 x 2

GROUP	sitefcp		{13} -2.96000	{14} -2.46000	{15} -.260000
1	1	{1}	.563751	.093781	.000000
1	2	{2}	.519742	.081711	.000000
1	3	{3}	.000171	.006113	.038995
2	1	{4}	.031564	.287613	.000234
2	2	{5}	.117096	.640919	.000026
2	3	{6}	.000344	.010679	.024034
3	1	{7}	.563751	.594071	.000000
3	2	{8}	.098114	.578816	.000036
3	3	{9}	.000000	.000001	.755764
4	1	{10}	.594070	.102608	.000000
4	2	{11}	.089605	.548881	.000043
4	3	{12}	.000000	.000000	.184550
5	1	{13}		.268128	.000000
5	2	{14}	.268128		.000004
5	3	{15}	.000000	.000004	

E8 - Fisher LSD post-hoc tests

POST Interval 7 (Site Matrix)

css/3: general manova — LSD TEST; variable Var.1 — Probabilities for Post-Hoc Tests — MAIN EFFECT: sitefcp

GROUP	sitefcp		{1} -2.18600	{2} -2.08600	{3} -.618000
....	1	{1}		.552536	.000000
....	2	{2}	.552536		.000000
....	3	{3}	.000000	.000000	

POST Interval 7 (Interaction Matrix)

css/3: general manova — LSD TEST; variable Var.1 — Probabilities for Post-Hoc Tests — INTERACTION: 1 x 2

GROUP	sitefcp		{1} -1.97000	{2} -2.56000	{3} -1.07000	{4} -1.53000
1	1	{1}		.119201	.018471	.243823
1	2	{2}	.119201		.000143	.007279
1	3	{3}	.018471	.000143		.223211
2	1	{4}	.243823	.007279	.223211	
2	2	{5}	.353211	.013996	.146007	.810902
2	3	{6}	.003638	.000016	.558950	.073152
3	1	{7}	.831572	.177286	.010519	.169027
3	2	{8}	.576923	.035643	.069102	.541259
3	3	{9}	.000049	.000000	.065241	.002640
4	1	{10}	.069102	.790364	.000054	.003360
4	2	{11}	.769974	.203896	.008446	.146007
4	3	{12}	.000080	.000000	.086504	.003937
5	1	{13}	.048545	.670684	.000030	.002065
5	2	{14}	.243823	.690145	.000570	.021154
5	3	{15}	.000054	.000000	.069102	.002862

css/3: general manova — LSD TEST; variable Var.1 — Probabilities for Post-Hoc Tests — INTERACTION: 1 x 2

GROUP	sitefcp		{5} -1.62000	{6} -.850000	{7} -2.05000	{8} -1.76000
1	1	{1}	.353211	.003638	.831572	.576923
1	2	{2}	.013996	.000016	.177286	.035643
1	3	{3}	.146007	.558950	.010519	.069102
2	1	{4}	.810902	.073152	.169027	.541259
2	2	{5}		.042971	.254624	.709817
2	3	{6}	.042971		.001901	.017246
3	1	{7}	.254624	.001901		.441414
3	2	{8}	.709817	.017246	.441414	
3	3	{9}	.001249	.203896	.000022	.000363
4	1	{10}	.006752	.000006	.107352	.018471
4	2	{11}	.223211	.001479	.936424	.395805
4	3	{12}	.001901	.254624	.000036	.000570
5	1	{13}	.004258	.000003	.077399	.012146
5	2	{14}	.037955	.000073	.339694	.086504
5	3	{15}	.001360	.213393	.000024	.000398

E8 - Fisher LSD post-hoc tests

POST Interval 7 (Interaction Matrix) - Continued

css/3: general manova — LSD TEST; variable Var.1 — Probabilities for Post-Hoc Tests — INTERACTION: 1 x 2

GROUP	sitefcp		(9) -.370000	(10) -2.66000	(11) -2.08000	(12) -.420000
1	1	(1)	.000049	.069102	.769974	.000080
1	2	(2)	.000000	.790364	.203896	.000000
1	3	(3)	.065241	.000054	.008446	.086504
2	1	(4)	.002640	.003360	.146007	.003937
2	2	(5)	.001249	.006752	.223211	.001901
2	3	(6)	.203896	.000006	.001479	.254624
3	1	(7)	.000022	.107352	.936424	.000036
3	2	(8)	.000363	.018471	.395805	.000570
3	3	(9)		.000000	.000016	.894242
4	1	(10)	.000000		.125504	.000000
4	2	(11)	.000016	.125504		.000027
4	3	(12)	.894242	.000000	.000027	
5	1	(13)	.000000	.873257	.091376	.000000
5	2	(14)	.000000	.506749	.381269	.000001
5	3	(15)	.978788	.000000	.000018	.915302

css/3: general manova — LSD TEST; variable Var.1 — Probabilities for Post-Hoc Tests — INTERACTION: 1 x 2

GROUP	sitefcp		(13) -2.72000	(14) -2.41000	(15) -.380000
1	1	(1)	.048545	.243823	.000054
1	2	(2)	.670684	.690145	.000000
1	3	(3)	.000030	.000570	.069102
2	1	(4)	.002065	.021154	.002862
2	2	(5)	.004258	.037955	.001360
2	3	(6)	.000003	.000073	.213393
3	1	(7)	.077399	.339694	.000024
3	2	(8)	.012146	.086504	.000398
3	3	(9)	.000000	.000000	.978788
4	1	(10)	.873257	.506749	.000000
4	2	(11)	.091376	.381269	.000018
4	3	(12)	.000000	.000001	.915302
5	1	(13)		.410676	.000000
5	2	(14)	.410676		.000001
5	3	(15)	.000000	.000001	