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A test of a dual central pattern generator hypothesis for subcortical control of locomotion

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**A Test of a Dual Central Pattern Generator Hypothesis
for Subcortical Control of Locomotion**

by

Michael Lee Rodrigue II

**A thesis submitted in partial fulfillment
of the requirements for the degree of**

Master of Science

in

Kinesiology

**Department of Kinesiology
University of Nevada, Las Vegas
December 1996**

Running Head: Dual CPG Hypothesis

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ABSTRACT

Of the skills acquired by most animals, none is more crucial than that of locomotion. An understanding of how locomotion occurs can help prevent or possibly restore its loss. Observations of coordination and reflex gating during locomotion display characteristics indicative of subcortical influence. Comparisons of normal and abnormal locomotor systems have shown remarkable similarities in both cats and humans. These findings support the existence of neural circuits in the spine and cerebellum that coordinate muscle activity and reflex activity during locomotion. These circuits are generally called central pattern generators (CPG's). A CPG is typically described as being capable of receiving a tonic input and generating alternating sets of commands rhythmically. Given the discovery of CPG's in cats and the behavioral similarities between neuronal control of cat and human locomotion, it is likely that such a circuit also exists in humans. However, the organization of this circuit has not been established with regard to its potential dual role in coordination and reflex gating. A task that strains the modulation of reflexes but not coordination (e.g., out-of-phase walking) may yield dissociative patterns of errors, which would provide important information about the complexity of the subcortical circuitry. In the present study, nine participants walked on a treadmill at 0.83 Hz cadence, timing their heelstrikes to a metronome which varied the phase lag between each leg from 0.5 to 1.0 π radians at 0.1 π intervals. Timing error was recorded for the left heelstrike. A stimulus was delivered to the sural nerve of the left leg, and reflexes were measured in the ipsilateral and contralateral tibialis anterior and contralateral gastrocnemius through electromyography. Analyses of variance revealed a significant main effect of stimulus delay on the contralateral tibialis anterior response ($F = 10.11$, $p < 0.05$), which is consistent with previous studies. The absence of differences between phase lag conditions for both temporal coordination and reflex intensities suggests that they may be controlled by the same subcortical circuitry. Within this explanation, two plausible alternatives exist. There may exist a single CPG that not only coordinates muscular contractions, but also phasically inhibits activity of Ia afferents to modulate reflexes using a feed-forward control scheme. Alternatively, there may also exist two separate circuits which are strongly entrained, producing synchronous outputs for both coordination and reflex gating. Discovery of a task which could exceed the capability of this entrainment may produce a dissociation. It is apparent that the out-of-phase task used in this study is not capable of discerning such a difference, if it exists.

TABLE OF CONTENTS

ABSTRACT.....	iii
ACKNOWLEDGEMENTS.....	vi
CHAPTER 1 INTRODUCTION.....	1
CHAPTER 2 LITERATURE REVIEW.....	9
Animal Studies.....	10
Coordination.....	11
Reflexes.....	11
Human Studies.....	14
Coordination.....	15
Short latency reflexes.....	17
Long latency reflexes.....	19
Conclusions.....	25
CHAPTER 3 METHODS.....	27
Participants.....	27
Design.....	27
Procedures.....	28
CHAPTER 4 RESULTS.....	31
CHAPTER 5 DISCUSSION.....	33
Implications.....	35
APPENDIX A - Sample EMG data from Myosoft.....	37

APPENDIX B - Sample Analysis from Myosoft.....	38
APPENDIX C - Sample Analysis of Timing and Reflex Data.....	50
APPENDIX D - SAS Program for ANOVA's.....	54
APPENDIX E - SAS Output for ANOVA's.....	70
APPENDIX F - SAS Program for Simple Main Effects.....	147
APPENDIX G - SAS Output for Simple Main Effects.....	158
APPENDIX H - Graphs of Means.....	194
REFERENCES.....	201

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CHAPTER 1

INTRODUCTION

Movement is of primary importance to virtually all animal species. Even animals that spend their entire lives in one location rely on movement for such basic operations as acquiring nutrition and oxygen, excreting waste products, and reproducing. For most animals, movement in and around their environment is the primary means through which these goals are reached. The loss of this ability results in a drastically reduced chance of survival for these species. This makes the task of understanding human and animal locomotion, and the mechanisms behind it, of utmost importance. Therefore, the current study examined the structure of the neural circuitry controlling locomotion as it applies specifically to humans.

It has been known for some time that many animals possess spinal mechanisms for controlling locomotion. The precise neural circuitry responsible for this control has been elucidated in some simple species as well as some mammalian systems (e.g., Sillar & Roberts, 1988; Prochazka, 1989; Jankowska, 1992; Capaday & Stein, 1987b). For example, when a cat's spine is transected, it appears to be able to walk somewhat normally, with basic coordination and reflex activity like that found in normal cats. This "fictive locomotion" lends support to the notion of spinal circuitry for locomotion in mammals as well as lower organisms (Andersson, Forssberg, Grillner, & Lindquist, 1978). Many behaviors observed in cats (especially those involving reflexes) can also be

observed in humans (e.g., Duysens, Tax, van der Doelen, Trippel, & Dietz, 1991; Belanger & Patla, 1987). Although the computational demands of walking on two limbs are greater than those of walking on four, behavioral similarities between cats and humans exist; these similarities suggest some degree of spinal control of locomotion in humans like that found in cats.

Exactly how much control of locomotion occurs in the spine is difficult to ascertain in humans. A great deal of motor activity results from both spinal and super-spinal mechanisms, and the contributions of each are almost impossible to dissociate. Even in cats, fictive locomotion is not as smooth as normal locomotion (Andersson et al., 1978). Humans possess even finer control and a much more complicated system than do cats (Rossignol & Gauthier, 1980*). In fact, it is this complexity of the human nervous system which may help decipher the internal control mechanisms involved in locomotion.

An underlying assumption of fictive locomotion is that subcortical circuitry is responsible for coordinating the onset, duration, and magnitude of muscular contractions. In fact, single neurons have been identified in cats that, when given a tonic pulse of a specific frequency, give rise to walking motions (Edgerton et al., 1976). This is congruent with the spinal circuitry found in lower animals: a single tonic train of afferent signals gives rise to two or more alternating patterns of signals (Prochazka, 1989). Because of the central location of this type of circuitry and its function, it has been given the name central pattern generator (CPG). The observation of induced walking from a single tonic pulse supports the existence of CPG's in cats.

Coordination is not the only type of control which may exist on a spinal level. For example, cats possess reflexes that prevent them from stumbling while walking (Forssberg, 1979; Holmqvist, 1961). During the swing phase of locomotion, when the dorsal surface of a cat's foot comes in contact with an object, a two-phase response is observed. First, the limb flexes and is lifted over the object. Second, the limb is extended and placed onto the object. Interestingly, during stance, this same stimulus elicits no response (Forssberg).

A similar reflex can be found in humans, where flexion is observed when a stimulus is delivered to the posterior tibial or sural nerve and the leg is in the swing phase. During stance, the same stimulus elicits extension although the actual intensity achieved in individual muscles varies. This gating of reflexes has been observed during walking (Duysens, Tax, van der Doelen, Trippel, & Dietz, 1991; Belanger & Patla, 1987), standing (Yang & Stein, 1990), running (Capaday & Stein, 1987a, Patla & Belanger, 1987), pedaling (Patla & Belanger, 1987, McIlroy & Brooke, 1987), and hopping (Patla & Belanger, 1987).

Naturally, investigations of coordination and reflex gating at the spinal level in humans are more subtle than the direct neurophysiological techniques used with lower animals, requiring that inferences be drawn through indirect observations. For example, the temporal coordination of walking in humans has been studied in newborn infants through the stepping reflex. Even in infants, who have been walking for only 6 months, the relative duration of each step has been shown to be identical to that of adults, indicating a high degree of automaticity (Clark, Whitall, & Phillips, 1988). The assumption is that the undeveloped system is fairly analogous to a purely spinal model.

The distance of each stride, however, correlates with cortical development, indicating some degree of cortical control with regard to normal walking. An additional source of information implicating spinal mechanisms of control comes from observations made of abnormal neurological systems, such as participants suffering from cerebrovascular accidents (CVA). Participants with hemiplegia (loss of motor function resulting from a unilateral stroke) experience spatial variability in walking, but the temporal coordination of each part of the leg remains constant compared to the unaffected leg and normal walking. (Barela et al., 1995)

Differentiating between the spinal and cortical influences in reflex gating is more direct than in muscular coordination, primarily due to the use of latency paradigms. In humans, two general responses can be observed from a stimulus given to the sural nerve. The first (P1) typically has a latency of about 40 - 70 ms, and is observed only in the ipsilateral leg. Its amplitude is independent of the stimulus strength, and occurs only during small windows in the gait cycle (Belanger & Patla, 1984). These observations are characteristic of spinal reflexes like the Hoffman (H) reflex, indicating that some reflex gating does occur at a purely spinal level (Berger, Dietz, & Quintern, 1984; Capaday & Stein, 1987b). In addition, the short latency supports the existence of one to three interneurons between sensory afferents and muscle efferents, making reflex gating through complex spinal circuitry more plausible than cortical mechanisms (Capaday & Stein, 1987b; Riedo & Ruegg, 1988). The second response (P2) has a latency of 100 - 120 ms, and can be found in both the ipsilateral and contralateral legs. In each leg, the response involves different muscles, typically causing flexion in one leg and extension in the other.

The responses are often scaled to the strength of the stimulus, and appear to be more corrective and stabilizing in nature (Belanger & Patla). Because of the latency and the bilateral nature of the P2 reflexes, they either involve more complicated spinal circuitry or lower super-spinal areas, like the cerebellum (Capaday & Stein, 1987b).

In cats, P2 responses were observed even when the spine was transected, implicating spinal mechanisms as their source (Rossignol & Gauthier, 1980). However, spinal mechanisms do not necessarily exist in humans. It is possible that being bipedal requires higher level processing to producing stabilizing reflexes than quadrupedal locomotion does. The small size of P1 in humans (relative to cats) may suggest the reliance on more complicated gating mechanisms in quadrupedal walking.

One assumption made during studies of spinal cats was that the same circuit that controls coordination also controls reflex gating. The observation of both behaviors without super-spinal influence certainly supports this assumption, because transections at different levels either produced both behaviors or neither (Rossignol & Gauthier, 1980). However, there are other possible explanations for these observations. Given that there are two tasks (coordination and reflex gating) which may not be under cortical control, there may be two separate circuits, each having some degree of super-spinal control. They may be linked together or may be synchronized through parallel top-down commands (Jankowska, 1992). If two separate circuits do exist, then they may have different characteristics that will yield a dissociation when a task is employed that strains one circuit but not the other. Presumably, the more adaptable of the two circuits will exhibit fewer errors than the more rigid circuit when a task is involved that involves

complicated timing and reflex activity. The task must be similar enough to walking to utilize the same circuitry, but possess enough computational difficulty to strain each possible circuit.

One such task may be limping. In quadrupeds, a number of phase relationships have been identified, yielding different types of locomotion (e.g., canter, gallop, trot, etc.) (Duysens & Tax, 1994). In humans, temporal constancy of phase has been confirmed in infants, toddlers, and adults in a walking task (Clark et al., 1988). Biomechanical similarity has also been noted between hemiplegic and normal gait (Barela et al., 1995). However, Boylls, Zomlefer, and Zajac (1984) found out-of-phase cycling to be under super-spinal control and free of neurological constraints like those seen in cats in out-of-phase walking. This would implicate higher mechanisms as being primary in controlling out-of-phase tasks like limping.

Reflex gating has also been examined in tasks with varying phase lags like running, walking, cycling (all with phase lags of 0.5 cycles or π radians), and hopping (with a phase lag of 0.0 cycles or 0 radians) (e.g. Capaday & Stein, 1987a; McIlroy & Brooke, 1987; Patla & Belanger, 1987). Different patterns of reflexes were observed with these different phase lag tasks, suggesting either separate circuits responsible for gating in each task or, more plausibly, complex circuitry that controls many tasks. Although the patterns of reflex responses differed, their sub-cortical nature was evident.

If two (or more) circuits exist for coordinating the musculature during walking and gating reflexes, then they may act as one through entrainment. When neural circuits are entrained, their phases become locked together. The relationship that results from this

phase locking is constrained to certain ratios that are determined by the strength of the linking between the two circuits (Duysens & Tax, 1994). An entrained system with rigid links will be constrained to a small number of ratios. A more flexible system will allow many ratios between the two systems. Entrainment has been shown to exist in cats between fore- and hind-limbs (Drew & Rossignol, 1985), and entrainment-like behaviors have been observed in humans between arms and legs and each leg during walking, both in normal participants and those suffering from spinal cord injury (Kearney & Chan, 1981).

The examination of temporal coordination and reflex gating in a task with various phase lags may strain the proposed two circuits to varying degrees depending on the amount of super-spinal control and the degree of entrainment between them. Circuits with a great deal of super-spinal control will be more flexible than those which are hard-wired into the spinal circuitry. Because coordination in an out-of-phase task appears to be super-spinal in humans (Boylls et al., 1984), it is likely that temporal error will remain constant during limping

Reflex gating, as discussed previously, exhibits characteristics that indicate it is under more spinal control than coordination may be. As a result, the strength of reflex responses may vary across phase lag conditions in a weakly entrained system, particularly with contralateral responses. The lack of rigidity between the coordinating and reflex gating circuitry would allow these variations to occur in the following manner: in selecting a response, the gating circuitry would operate under the standard phase lag options of 0 or π radians, resulting in an inappropriate reflex for the true phase of the contralateral leg. If the gating circuitry does not share the same temporal information

available to the coordinating circuitry, then it is forced to operate as it usually does, rather than adapt to the requirements of a new task.

On the other hand, a strong entrainment between coordination and gating circuitry will likely yield reflex responses with a constant latency across various phase lags in the ipsilateral and contralateral leg. This is because the reflex gating circuit is locked in phase with the temporal coordination circuit, and may be pulled from a natural tendency for phase lags of π or 0 radians. If the coordination circuit itself is flexible enough to allow various phase lags, then accurate coordination of temporal parameters will be observed.

Note that similar observations may be observed for both strongly entrained dual circuits and a single CPG which control both coordination and reflex gating. It may be difficult to dissociate two strongly entrained circuits, resulting in the appearance of similar patterns of errors. The same result can be expected of a single CPG. Coordination and reflex gating would vary together under both scenarios, irregardless of the system's ability as a whole to adapt to a novel task.

Thus, it is the purpose of the current study to determine whether separate circuitry exists for coordination of movement and gating of reflexes and if such circuits act independently of each other. This will be accomplished through the observation of temporal error (as a measure of coordination) and reflex intensity (as a measure of reflex gating) across varying phase lag conditions in an out-of-phase walking task.

CHAPTER 2

LITERATURE REVIEW

For many years, an understanding of the neuronal mechanisms underlying locomotion has been sought. Generally these investigations involved lower animals, primarily due to the simplicity of their nervous systems. While the simplicity of these systems prevents detailed comparison with higher organisms, the information gathered on lower animals has yielded interesting theoretical constructs. Specifically, the observation of a class of circuits called central pattern generators (CPG's) in lower animals can be expanded to higher animals as a possible way of controlling movement. This chapter will describe CPG's and their roles in both quadrupedal and bipedal locomotion. Quadrupedal gait will be examined in relation to cats, and bipedal gait of humans will be considered. Particular emphasis will be placed on the evidence related to differentiation of reflex and coordinative circuitry in both the cat and human.

A central pattern generator is a neuronal circuit that is capable of receiving a tonic neural impulse as its stimulus and generating a rhythmic pattern of pulses as its output. In lower animals, CPG's have been discovered both functionally and anatomically (Duysens & Tax, 1994; Sillar & Roberts, 1988). However, no such corresponding discovery has been made in higher animals like mammals. Part of the problem in finding CPG's in higher animals is knowing where to look. Unlike the leech or mollusk, mammals have a clearly differentiated brain and spinal cord, with mammals being far more complex than the lower

animals. The complexity of the brain and spinal cord give rise to more elaborate behaviors as well. It is not entirely clear whether one might expect to find CPG's in the brain, spinal cord, or both. Both structures can certainly accommodate one or more CPG's. A major step in answering this question has come from research performed on cats.

Animal Studies

Some of the earliest work came from Sir Charles Sherrington (1908, as cited in Holmqvist, 1961), who examined the reflex actions of cats and dogs whose spines had been transected at various levels. He found that a number of spinal reflexes, both ipsilateral and contralateral, existed in spinal cats and dogs. Interestingly, the responses were more pronounced in the cats. Likewise, there was some rudimentary coordination in the spinal animals. As the animals' foot was pushed back by the moving treadmill, the foot rolled over the toes onto the dorsal surface. This acted as the stimulus for an ipsilateral flexion response, which would pull the leg forward as it fell onto the treadmill again. In itself, this observation is not altogether remarkable, as one could simply attribute it to reflexive actions. What is noteworthy about this observation is that each leg would fall into an alternating pattern with regard to execution of the reflexes. If the treadmill was started with both feet together, they would settle into an alternating pattern, even when the spinal transection was between the fore- and hindlimbs. Although this could be thought of as a repetitive and complex reflex chain, it represents some degree of coordination in that it causes muscular contractions to follow a prescribed temporal pattern.

Coordination

Although the discovery of reflexes chains in cats was noteworthy, it did not necessarily imply that a CPG was involved in coordination. The key to a CPG is anatomical correlation to its proposed function. This was achieved by Edgerton et al. (1976). They found that a specific region in the cat's cerebellum, when stimulated electrically, gave rise to coordinated walking motions in the fore- and hindlimbs of decorticate preparations. Furthermore, an increase in the rate of stimulation produced an increase in walking speed. Spinal reflexes were still present in the hindlimbs in both the ipsilateral and contralateral legs. Hence, this region was called the locomotor region.

Even more notable than the discovery of CPG's in the cerebellum were the spinal preparations in which the same result was found for high spinal cats and coordination of the hindlegs. When specific neurons in the spine were stimulated, coordinated walking motions were observed, but only in the hindlegs. Although lacking the synchronicity with the forelimbs present in the decorticate cats, the relative phasing of the hindlegs by themselves was almost identical to normal walking. This implicated a circuit for coordination of the hindlegs that existed below the level of the transection (Edgerton et al., 1976).

Reflexes

How reflexes are modulated is a complicated question that requires an in-depth neurophysiological approach. There are many afferents that could possibly affect reflex activity, and it is difficult to isolate them (Jankowska, 1992). A key factor in describing

this process was to test the assumption that different neuronal mechanisms were responsible for ipsilateral and contralateral reflexes. Ipsilateral reflexes are thought to be caused primarily by monosynaptic arcs (Lisin, Frankstein, & Rechtman, 1973). One possibility with crossed reflexes was that they were linked to ipsilateral reflexes through some type of double reciprocal system, where the ipsilateral reflex served as the stimulus for the contralateral reflex. A study by Holmqvist (1961) found that crossed spinal reflexes showed a parallelism with the control of ipsilateral reflex arcs. However, this parallelism was only found in decerebrate preparations. Decorticate preparations showed differing patterns between ipsi- and contralateral reflexes when the cerebellum was left intact (Holmqvist). Thus crossed reflex pathways did exist at a spinal level, but these spinal reflexes were either ignored or modified by supraspinal (cerebellar) influences. The assumption was that stimulation of afferents caused excitation of both flexor and extensor muscles, but that extensors were masked through cerebellar influences. These influences (originating from a CPG) resulted in contralateral flexor activity by inhibiting the extensors at an appropriate time.

The involvement of the cerebellum in gating reflexes represents a major consideration in examining reflexes, as it is not clear whether a response can be attributed purely to a spinal reflexive pathway or supraspinal (cerebellar) influence. Furthermore, many responses, particularly extensor responses, were observed more easily in decerebrate than in spinal cats, implying that stronger responses require supraspinal influences. The notion of separate spinal and supraspinal pathways was supported by the observation of task dependency on reflex strength (Lisin et al., 1973). Whether lying or standing,

stimulation of the sural nerve elicited a flexor response. When the animal was made to walk, the response varied in a cyclic fashion from flexion to extension. Lisin et al. concluded that this response modulation could be caused by supraspinal inhibition like that suggested by Holmqvist (1961).

However, it was still not clear whether the inhibition Lisin et al. (1973) observed arose from central mechanisms affecting the motoneurons directly or from interaction with other reflex pathways that were activated during the step cycle. Prochazka, Sontag, and Wand (1978) illustrated that when afferent signals were eliminated in cats (through anaesthetization), an underlying system of stretch responses could be observed that were overridden by spinal influences when the afferent signals were present. Thus there existed a set of underlying reflexive pathways that could be modulated to produce the desired response. These reflexes could be affected by supraspinal pathways to execute a specific response without any influence by afferent information. This makes simultaneous independent coordination and reflex gating more plausible because there might actually be two anatomical sites for their execution. Coordination could take place at the level of the motoneuron, while the gating of reflexes would occur at the pre-synaptic interneurons or afferents responsible for the existing stretch reflexes.

In fact, it was the latter explanation that was found to be supported by intracellular recordings (Andersson et al., 1978). The site of modulation was limited to the post-synaptic potential at the alpha motoneurons in the shorter P1 (monosynaptic) responses; the pre-synaptic potential was unaffected. This result indicated a central mechanism for modulation of response strength that did not involve modulation of the afferent signal.

Andersson et al. went on to suggest two possible mechanisms through which a spinal generator could modulate reflex strengths. First: that the spinal generator synapsed directly on the motoneurons along with the reflex interneurons, resulting in a mutual facilitation of the response, or second: that the spinal generator could synapse on the interneuron, phasically inhibiting its activity. The important conclusion here was that the level of the inhibition was not at the sensory afferent.

If central mechanisms are the source of reflex gating in spinal cats, then it follows that normal cats may use the same mechanisms. Forssberg (1979) found this to be the case: normal cats exhibited two responses to noxious stimuli applied to the dorsum of the foot. Both the short- and long-latency responses were regulated so that the correction conformed with the phase of the gait cycle. This was consistent with observations from spinal and decorticated preparations. The lack of qualitative differences between the animals suggested that the circuit which modulated response strengths was not only spinal, but acts without any influence from superspinal pathways (Forssberg, 1979).

Human studies

The argument has been made that a large difference exists between cat and human locomotion, and is clear through simple observation. Cats are quadrupedal, while humans are bipedal; this alone represents a tremendous difference in complexity and coordinative demands. Likewise, investigation of the human nervous system is far more difficult than that of the cat for ethical and methodological reasons. There is some evidence to suggest that coordination and reflex gating may have at least some spinal control.

Coordination

Unfortunately, there is quantitatively little to support purely spinal coordination of locomotion in humans, as all “spinal” humans are confined to wheelchairs for the remainder of their lives. However, some distinction between spinal and cortical involvement has been made. Clark et al. (1988) examined the temporal phasing and distance phasing of walking in infants who had been walking for varying lengths of time. They compared these measures to adults and each other. As one might expect, distance phasing was far more consistent for adults than for infants; in fact, it was correlated with cortical development. However, the temporal phasing was found to be the same. Infants at all levels of experience had no problem maintaining a relative phasing of 50% between each leg. Thus temporal coordination of walking appears to be independent of cortical development. At least from a temporal standpoint, locomotion is likely controlled at a spinal level through circuitry that is “in place at the very onset of independent walking” (Clark et al., p. 455).

Another study examined coordinative characteristics of hemiparetics and normal participants to examine the quantitative differences between cerebral effects on gait. Barela et al. (1995) examined the kinematic characteristics of gait in normal and hemiparetic participants and found no significant differences in the phase portraits of each leg individually. Although the overall gait was noticeably slower in the hemiparetic participants, the ankle-thigh angular relationships remained the same for both groups. Thus the lack of cortical control affected the overall size of the walking motion, but did

not affect the temporal relationships within each limb. It appeared as though much of the temporal coordination was present, even in the affected leg, which had no cortical control.

When the legs in human participants are forced to act independently in a cyclic task like pedaling, they exhibit consistent patterns within each leg, even when the velocities of the individual legs differ (Boylls et al., 1984). The EMG patterns found in each leg are identical relative to their respective velocities, which is not the case in spinal and normal cats whose legs are forced to fictively walk at different velocities (Forssberg, Grillner, Halbertsma, & Rossignol, 1980). It would appear that control mechanisms in humans are capable of fluid temporal coordination without the neural constraints seen in cats. In addition, Boylls et al. (1984) concluded that the source of the minute variations in coordination were not the result of simple spinal reflex synergies but rather more complicated circuitry that was capable of attending to both legs simultaneously. Therefore, it is quite likely that out-of-phase locomotor tasks can be executed with the same temporal precision as normal locomotor tasks through superspinal influences.

Examination of reflex activity in humans has been investigated in much greater detail, and justly so: the number of confounding factors in their examination is staggering. The notion of textbook monosynaptic reflexes like the withdrawal reflex can even be questioned. It has been found that the startle response can contaminate the withdrawal reflex (Dowman, 1992), requiring a high degree of control over experimental conditions. Confounds to measurement of EMG activity also exist in responses to muscle stretch (Toft, Sinkjaer, Andreassen, & Larsen, 1991), which presents itself numerous times throughout the gait cycle. In addition, noxious stimuli can cause long-lasting effects in

reflex excitability for not only contralateral reflexes, but also in reflexes that exist through longitudinal synergies, like those between arm and leg in humans or fore- and hindlimb in cats (Gassel & Ott, 1973).

Short latency reflexes

Humans, like cats, exhibit both a short and long latency response to perturbation during gait. Short latency responses typically have a latency of around 40 ms, which would make the total neuronal pathway no longer than three neurons, eliminating the possibility of supraspinal influences (Schieppati 1987). These characteristics are typical of the Hoffman (H) reflex, a member of a class of monosynaptic reflexes that include the tendon jerk and withdrawal reflexes. H reflexes are affected by passive muscle stretch, voluntary muscle contraction, and baseline muscle activity (Verrier, 1985). During locomotion, H reflexes can be modulated in response to form of locomotion (e.g., running vs. walking), which can be attributed to the duration of the swing phase relative to stance (Edamura, Yang, & Stein, 1991).

Even in the case of the monosynaptic H reflex, there are three potential sites of modulation: the presynaptic Ia afferent, the receptors (through gamma motoneuronal activity), and the postsynaptic alpha motoneuron (Edamura et al., 1991). Given the efficiency of the modulation of these reflexes and the fact that Ia afferent activity is not necessarily correlated to alpha motoneuron response (and thus reflex intensity), it has been suggested that the site of modulation is the presynaptic Ia afferent (Capaday & Stein, 1987a; Morin, Katz, Mazieres, & Pierrot-Deseilligny, 1982). Further observations of the quadriceps tendon jerk reflex (Dietz, Discher, Faist, & Trippel, 1990), quadriceps H reflex

(Dietz, Faist, & Pierrot-Deseilligny, 1990), and soleus H reflex (Llewellyn, Yang, & Prochazka, 1990) support the inhibition of Ia muscle spindle afferents as the primary site of modulation.

An interesting observation related to the short latency H reflex is its modulation during different tasks. The H reflex is much larger for normal walking than in balance beam walking (Llewellyn et al., 1990), which may be attributed to a higher degree of background activity in walking. However, H reflex activity is much lower for running, despite a much higher level of background EMG activity (Capaday & Stein, 1987a). This suggests central involvement as an overriding factor, which is supported also by similar observations for hopping (Moritani, Oddson, & Thorstensson, 1990). Finally, it has been found that passive rotation of a single leg in a pedaling task results in a different pattern of reflex modulation than active pedaling. The difference between passive motion and planned movement demonstrates the effects of central involvement as an overriding factor, even in monosynaptic H reflexes (McIlroy, Collins, & Brooke, 1992).

Cyclic reflex reversal also occurred in humans that had hemiparesis but not in normal humans (Lisin et al., 1973). This dissociation was an important find because it implied a different neuronal mechanism for reflex gating in humans than the mechanisms found in cats. It was previously thought that the cause of the flexor reflexes in humans was similar to that of cats: inhibition of the motoneurons to the extensors gave rise to increased flexor activity. However, this explanation could not account for the difference between hemiparetic and normal humans since their efferent capabilities were not affected; rather, it was the afferent information that was lacking in the hemiparetics. If the site of

the reversal were the unaffected motoneurons, then there should be no dissociation between the hemiparetic and normal participants. Lisin et al. concluded that the cyclic nature of crossed reflexes arose from inhibition of the flexor reflex afferents, not the motoneurons. As a result, the extensor reflexes occurred.

Long latency reflexes

There also exist a class of reflexes that occur during locomotion with longer latencies than the H reflex. These long latency reflexes typically occur in both legs, and can involve opposite responses in each leg (e.g. Berger et al., 1984; Dietz, Quintern, Boos, & Berger, 1986). The typical latency associated with this class of reflexes is 70 to 100 ms after stimulus onset, although longer reflexes have been observed in some instances (Yang & Stein, 1990). However, responses that occur later than 100 ms can be contaminated by cortical responses to the initiating stimulus.

There are two general theories that address how long latency reflexes originate. It is possible that the long latency reflex during locomotion is processed after the stimulus is presented. This would require rapid processing of the stimulus at a subcortical level and simultaneous information about the current state of not only the stimulated leg, but also the opposite leg so that an appropriate contralateral response can be made. The second possibility involves the availability of such information in advance, in essence priming the reflexive circuitry for a proper response. Although the latter (a feed-forward system) would enable faster responses, the accuracy of the response would suffer if the information provided were incorrect. The former alternative (a feed-back system) allows for evaluation of the current state of all afferents before a response is selected. It is

important to note that although the modulation of long latency reflexes appears to involve decision making processes characteristic of cortical control, the timing of such responses makes such an explanation highly unlikely (Schieppati, 1987).

If the long latency reflexes followed the same model as the H reflex modulation, then the site of modulation would be at the level of the Ia afferent (Capaday & Stein, 1987b). However, this would be incongruent with their sudden onset. The examination of normal human participants subjected to treadmill acceleration during walking shows two clearly separate responses without overlap (Berger, Dietz, & Quintern, 1984). Even blockade of Ia afferents by ischaemia (thus eliminating short latency responses) failed to eliminate the long-latency reflexes. This dissociation fails to support the notion of long-latency reflexes as feed-forward mechanisms.

In fact, there is evidence to suggest that long latency pathways, unlike the monosynaptic pathways of short latency reflexes, involve afferent information from both Ia and Ib afferents (Jankowska, 1992). In fact, the anatomical site (laminae VI and the dorsal part of laminae VII) of these Ib interneurons is primarily associated with post-synaptic modulation of α -motoneurons, γ -motoneurons, and synapses onto other Ib interneurons. Thus a distinction exists between short and long latency reflexes in that short latency reflexes are likely the result of a feed-forward inhibitory system on Ia afferents, while long latency reflexes are feedback oriented, relying on modulation of the existing efferent command. If this is the case, then one can expect to observe long latency responses that are primarily modulations of existing muscle activity rather than reversal or neutralization of muscle activity. (Prochazka, 1989) This is the case, as can be found in

examination of high intensity responses resulting from nociceptive stimuli. Crenna and Frigo (1984) found that humans exhibit a great deal more plasticity than animal preparations. Where cats typically experience a large flexor response to a painful stimulus throughout the entire gait cycle, human responses are typically more controlled. This probably results from the decreased stability of bipedal walking (Crenna & Frigo, 1984). The differentiation of short and long latency reflexes is also more distinct in humans than cats.

Long latency reflexes have been examined in detail with regard to a number of muscles, stimulation techniques, and measurement techniques (e.g., Berger et al., 1984; Belanger & Patla, 1984; etc.). The most common method of investigation involves electrical stimulation of a nerve transcutaneously and measurement of EMG activity in various muscles throughout the leg during walking. However, mechanical perturbations have also been used to elicit responses. The advantage of mechanical perturbations lies primarily in the similarity of the stimulus to those encountered in non-experimental situations. However, the mechanical perturbations cannot be controlled as precisely as electrical stimuli.

Berger, Dietz, and Quintern (1984) used randomly timed accelerations and decelerations of the treadmill to induced reflexes at certain points in the gait cycle. They examined the reflexes of the lower leg, primarily those in the tibialis anterior (TA) and gastrocnemius (GS). They found a coordinated response during the swing phase involving activity in both muscles, the end result of which was to end the swing phase prematurely. However, this response was caused by many stimuli from throughout the body because of

the general nature of the treadmill acceleration.

To control this, Dietz et al. (1986) used a restraining cord and repeated the experiment, examining not only the TA and GS, but also the rectus femoris (RF) and biceps femoris (BF). Resistance was applied to the restraining cord from behind the participant, so the leg would appear to be obstructed by an object. They found the same multi-phasic response during swing, and little activity during stance. However, the involvement of the contralateral leg was more marked in this scenario. Unfortunately, this general approach to reflex investigations does not provide for the degree of control needed to isolate a single reflexive response to a single afferent.

Of more use to this end are protocols which provide a stimulus to a single afferent. This is most easily obtained through transcutaneous electrical stimulation of a nerve at a point where it runs just below the surface of the skin. The nerves most typically used are the tibial or sural nerve (e.g., Yang & Stein, 1990; Duysens, Trippel, Horstmann, & Dietz, 1990; Duysens, Tax, van der Doelen, Trippel, & Dietz, 1991). Some studies have used a copper ring placed around the second toe to stimulate the sural nerve (Belanger & Patla, 1984, 1987; Patla & Belanger, 1987), but the degree of innervation overlap may vary between individuals, making it unclear as to whether the tibial or sural nerve is totally isolated.

The results of a number of studies are summarized in Figure 1 (for tibial nerve stimulation) and Figures 2 and Figure 3 (for sural nerve stimulation). A great deal of activity occurs in both the ipsilateral and contralateral limbs during the swing phase. However, the sural nerve stimulation is much more consistent between studies in eliciting

responses than the tibial nerve. Part of the variation may be explained by the fact that there are two potential sites for tibial nerve stimulation: the ankle and the popliteal fossa at the knee. However, there exists some variation between findings even within a given site of stimulation of the tibial nerve. Thus the sural nerve seems to be the most reasonable candidate for fine investigation of reflexes during walking.

Figure 1 - Tibial Stimulation

Figure 2 - Sural Stimulation

Figure 3 - Sural Stimulation

Many investigations have compared responses found during normal walking to other locomotor activities, such as running, hopping, and cycling. In many of these cases, dissociations between these activities exist (see Figure 4). However, the responses found during running and cycling (which share the same phase lag as walking) appear to be scaled versions of the reflexes normally found during walking (Patla & Belanger, 1987;

McIlroy & Brooke, 1987). Hopping, which has an opposite phase lag from walking, exhibits a very different pattern of reflexes, primarily in the contralateral leg (Patla & Belanger, 1987). This suggests that the contralateral leg may be the site of interest in a varying phase task, possibly yielding a stronger dissociation than those reflexes of the ipsilateral leg.

Figure 4 - Sural Stimulation

CONCLUSION

There is some substantial evidence that suggests different circuitry may be involved in the coordination and reflex gating of locomotion. If this is the case, then a task that strains one circuit and not the other may yield a dissociation between the patterns of errors for each task. Limping may be one such task. If timing is under more super-spinal control than reflex gating, then temporal error may fluctuate less between phase lag conditions than reflex intensities in the ipsi tibialis anterior (TA), contra TA, and contra

gastrocnemius (GS). A difference in patterns of errors would support the existence of two separate circuits, one for each task. However, if no difference is observed, there may yet be two circuits. The degree of entrainment between them may prevent dissociation, so that they act in unison. It is also possible that one circuit is responsible for both of these tasks.

METHODS

Participants

Nine individuals (5 males and 4 females) volunteered to participate in the study. All participants were students at the University of Nevada, Las Vegas and ranged in age from 20 to 34, with the mean age being 24. Additionally, all participants were free from spinal cord anomalies that would adversely impact their performance. Finally, all participants signed an informed consent prior to their participation in the study.

Design

The experimental design was a 2 (Stimulus Delay) x 3 (Trial) x 6 (Condition) mixed design. Stimulus Delay was a between-subjects factor with two levels, early and late stimulus delay, corresponding to points at roughly 15% and 80% through the swing phase of the left (ipsilateral) leg. Both Trial and Condition were within-subjects factors. Each participant completed three trials, each separated by approximately 15-20 step cycles, for each of the phase lag conditions ranging from 0.5π radians to 1.0π radians (at 0.1π radian increments) phase lag. The dependent variables of interest were Left Timing Error (LTIMERR), Ipsilateral Tibialis Anterior (REF1), Contralateral Tibialis Anterior (REF2), and Contralateral Gastrocnemius (REF3).

Procedures

Participants were asked to walk comfortably on a treadmill (International Medical Corporation) at a 0 degree incline and a .83 Hz cadence. Cadence was maintained using alternating high and low tones corresponding to the left and right heelstrikes, respectively. EMG recordings of the gastrocnemius medialis (right or contralateral leg) and tibialis anterior (both legs) were made using surface electrodes. Electrode sites were prepared by shaving the site and removing dead skin with a scouring pad. Conducting gel was included in the pre-packaged electrode. Electrodes were placed 0.5 cm above and below the motor point of each muscle. Impedance of each site was noted prior to testing and site preparation repeated if the impedance was greater than 10,000 ohms. Timing of heel-strike and toe-off were measured by custom-made electronic switches (approximately 15 mm diameter and 4 mm thick, spring steel and externally padded) connected to an amplifier. All EMG and timing data was recorded on a Gateway 2000 computer using Noraxon Myosoft software.

In addition to the recording measures described above, an electrical stimulus was applied to the sural nerve of the left leg. The purpose of this stimulus was to elicit a reflexive response in the muscles being monitored. The existence of these specific reflexes has been established in previous research (e.g., Belanger & Patla, 1987) using procedures similar to those used here. A bar electrode (Lafayette Instruments) was used to transmit the stimulus to the sural nerve transcutaneously posterior to the lateral malleolus. The source of the stimulus was an operating-room grade electrical stimulator (Grass Instrument Company, Model S44). A stimulus isolation/constant current unit (Grass

Instrument Company, Model SIU7) was used to accommodate any changes in impedance which may have occurred during the experiment and protect the participants from accidental discharges of current. The stimulation itself consisted of a train of six rectangular pulses of 1 ms, given over a period of 20 ms. The amplitude of these pulses was 2.5 times detection threshold (as determined by the method of limits prior to testing). The effect of this stimulation was sensation of a touch on the lateral side of the foot; the perception would be of contact with "most likely... an obstructing object." (Duysens & Dietz, 1991, p. 219) For each participant, relative stimulus strength was maintained throughout the experiment.

Participants were asked to walk on the treadmill at the predetermined speed and tempo mentioned above. Phase lag was varied by changing the delay between the high and low tones, with a delay of 0.5 cycle duration corresponding to a phase lag of π radians, etc. Participants were asked to time heel strikes with the metronome. During a randomly selected cycle (approximately 10 to 20 cycles apart), the stimulus was delivered at a point during the swing phase of the stimulated leg. Two stimulus delays were used. Participants 1, 2, 4, 7, and 9 received the stimulus approximately 80% through the swing phase (late), while participants 3, 5, 6, and 8 received the stimulus approximately 15% through the swing phase (early). Participants were tested in each phase lag condition (0.5 to 1.0 π radians at 0.1 π increments, order assigned randomly).

Data was prepared by flagging the left tone, left heel-strike and toe-off, right tone, right heel-strike and toe-off, stimulus onset, ipsilateral tibialis anterior, contralateral tibialis anterior, and contralateral gastrocnemius. The absolute time (in ms), value (in mV) and

area between flags (in mV x ms) was determined using Noraxon Myosoft's multiple marker analysis. From this data, the timing error, phase lag, stimulus delay, and reflex intensities were derived. Timing error was determined by the difference between the onset of the left tone and the corresponding left heel-strike. Phase lag was determined by dividing the duration of the left leg cycle by the inter-tone delay. Stimulus delay was calculated by dividing the stimulus onset relative to toe-off by the duration of the swing phase. Reflex intensity was derived by subtracting the area under the stimulated contraction (20-120 ms following stimulus onset) from the average area of the two preceding contractions at the corresponding point in the swing phase. The first 20 ms were eliminated from reflex intensity to eliminate widespread subcutaneous activation, which has been shown to contaminate recordings in similar protocols (Duysens & Dietz, 1991; Belanger & Patla, 1984, 1987)

RESULTS

The results from the ANOVA's performed on each of the dependent variables Left Timing Error (LTIMERR), Ipsilateral Tibialis Anterior Reflex (REFA), Contralateral Tibialis Anterior (REFB), and Contralateral Gastrocnemius (REFC) are summarized in Table 1. Significant interactions are indicated by an asterisk.

	LTIMERR		REFA	
COND	F = 2.13	p < 0.0877	F = 1.12	p < 0.3709
TRIAL	F = 2.98	p < 0.1081	F = 0.28	p < 0.7641
STIMDEL	F = 2.98	p < 0.1282	F = 0.35	p < 0.5708
COND x STIMDEL	F = 0.32	p < 0.8987	F = 0.33	p < 0.8912
TRIAL x STIMDEL	F = 0.17	p < 0.8502	F = 1.39	p < 0.3033
COND x TRIAL	F = 0.51	p < 0.8608	F = 0.61	p < 0.7855
COND x TRIAL x STIMDEL	F = 0.95	p < 0.5109	F = 0.79	p < 0.6392
	REFB		REFC	
COND	F = 0.61	p < 0.6964	F = 1.93	p < 0.1166
TRIAL	F = 0.04	p < 0.9637	F = 0.14	p < 0.8748
STIMDEL	F = 10.11 **	p < 0.0155	F = 4.46	p < 0.0727
COND x STIMDEL	F = 0.87	p < 0.5132	F = 2.69 **	p < 0.0386
TRIAL x STIMDEL	F = 3.13	p < 0.099	F = 0.76	p < 0.4981
COND x TRIAL	F = 1.30	p < 0.2969	F = 0.96	p < 0.5020
COND x TRIAL x STIMDEL	F = 0.84	p < 0.5987	F = 0.99	p < 0.4855

Table 1

For the dependent variables LTIMERR and REFA, analysis revealed no significant main effects of Condition, Trial, or Stimulus Delay. There were no significant interactions between these variables for LTIMERR and REFA. The dependent variable REFB showed a main effect of Stimulus Delay ($F = 10.11$, $p < 0.05$); all other main effects and

interactions were not significant. The dependent variable REFC showed no main effects, but did reveal a significant Condition x Stimulus Delay interaction ($F = 2.69$, $p < 0.05$). All other interactions for REFC were not significant.

Post hoc analyses were not needed for the dependent variable REFB and the independent variable Stimulus Delay due to the existence of only two levels of the variable Stimulus Delay. The reflex intensity of the contralateral TA varied from inhibition in early swing ($X = -1.63$) to almost non-existent in late swing ($X = -0.35$).

Simple main effects performed on the independent variable Condition and Stimulus Delay using the dependent variable REFC revealed a significant difference between Stimulus Delays at Condition 0.6π radians phase lag ($F = 4.19$, $p < 0.05$). All other differences between means were not significant.

DISCUSSION

The study of the underlying mechanisms behind locomotion is of importance because of locomotion's value to those who perform it. Life in the absence of locomotor abilities is notably more difficult than life with them. The hope for restoration of locomotor abilities in those who have lost them lies in the elucidation of the neural circuitry involved in not only coordination of the musculature involved, but also in the control of reflexes associated with normal locomotor function. The purpose of this study was to determine whether separate circuitry exists for coordination of movement and gating of reflexes and if such circuits act independently of each other. If different patterns of errors occurred in temporal error and reflex intensities, then it would support the concept of two separate circuits. Conversely, an absence of a dissociation would lend support to either a single circuit or two highly entrained circuits. These hypotheses were investigated by comparing the patterns of timing and reflex errors in a novel walking task. The results show a gait phase dependent difference in reflex intensity for the contralateral TA and a difference between stimulus delay conditions at phase lag 0.6π radians. There was no difference in temporal error or reflex intensity between different phase lag conditions.

Phase lag condition had no significant effect on neither timing error nor any of the three reflexes examined. This lends support to the notion of either a single circuit or double entrained circuits that control temporal coordination and reflex gating not only in

normal walking, but in similar tasks as well. A high degree of plasticity is present to accommodate the demands of a difficult walking task. The absence of a main effect of trial for all the dependent variables is an indication of the absence of learning effects or the effects of neuronal adaptation.

The effect of stimulus delay on the contralateral tibialis anterior response is a replication of many previous studies which have examined the nature of crossed spinal reflexes during walking. In the early part of the swing phase, this reflex is typically less excitatory than at later points in the swing phase (Belanger & Patla, 1984). The exact intensity of the responses varies between participants, but the relative intensities are consistent. The observation of a decrease in the inhibitory response of the contralateral tibialis anterior between early and late swing is congruent with other investigations (e.g., Duysens et al., 1991; Belanger & Patla, 1987). Stimulus delay had no significant effect on the ipsilateral TA or the contralateral GS response. Both of these responses have been shown to be fairly constant throughout the swing phase (Belanger & Patla, 1984). Stimulus delay would only affect the timing error if the response was large enough to elicit a kinematically significant effect. The stimulus intensity was chosen to prevent this confound, as stimulus delays greater than $2.5 \times$ threshold tend to result in responses that are measurable when the biomechanics of the leg are considered. (Dowman, 1992)

There was an interaction between stimulus delay and phase lag condition for the variable contralateral GS. The discovery of a dissociation between stimulus delay conditions at the 0.6π phase lag condition may have been the result of the position of the contralateral leg at that time of stimulation. In early swing ($STIMDEL = 1$), the typical

contralateral GS response is slightly excitatory (Belanger & Patla, 1987). The late swing response (STIMDEL = 2) in the contralateral GS is typically slightly inhibitory, but in the 0.6π phase lag condition, the contralateral leg is even closer to toe-off at the same stimulus delay than in normal walking. Since the contralateral response becomes more inhibitory as the late swing phase progresses, the presence of the significant inhibitory response in this condition is congruent with previous research. (Please refer to Appendix H for graphs of the means of each dependent variable at each level of the independent variables).

Implications

The present study shows similar patterns of errors for timing and reflex intensity across phase lag conditions. This supports either a single CPG that is capable of controlling both coordinative and gating tasks, or dual entrained CPG's that function as a single coordinated unit. It is also suggested that these tasks experience some degree of supraspinal control. When normal walking suffers as a result of injury or deterioration, the capacity may eventually exist to restore locomotor ability through reconstruction or artificial stimulation of the circuits discussed in this study. The findings of this study may be used to narrow the search for such circuits by demonstrating the similarities between the two functions. If the anatomy (i.e., location) of these circuits is also parallel, then one may expect to find either the individual circuits very near each other or locate a single circuit that can accommodate most of the needs of restored locomotion. If two circuits are eventually identified as individual circuits, then their functional link may indicate an anatomical link as well, making the discover of the second much easier. The current study

reinforces the plasticity of the human locomotor system.

APPENDIX A - Sample EMG data from Myosoft

APPENDIX B - Sample Analysis from Myosoft

PARTICIP sjm1 3, TES 0
ANT: TNU
MBE
R:

EXERCISE FREQUENC 1000
: Y:
AGE: DURATION: 7910
HEIGHT: START: 0
WEIGHT: END: 7910

Channel Mark	Time	1 Stimulus	Va	lue	Area	Total Area	Slope
1	1194.3	5620 mV	103.6	103.6	4706		
2	2550.2	5742 mV	181	284.6	89.98		
3	3911.2	7187 mV	188.1	472.7	1062		
4	5217.2	5903 mV	172.8	645.5	-983.1		
5	6390.5	7416 mV	195.5	841	1290		
6	7562.3	7490 mV	174	1015	63.15		

Channel Mark	Time	2 Left Tone	Va	lue	Area	Total Area	Slope
2	1355.2	7885 mV	168.7	250.9	5965		
3	2731.3	8867 mV	288.6	539.5	713.6		
4	4105.5	8310 mV	200.7	979.2	1215		
5	5483.5	7182 mV	309.3	1288.	-818.6		
				5			
6	6858.2	8754 mV	294.9	1583.	1144		
				4			

Channel Mark	Time	3 Left Foot Value	Area	Total Area	Slope
1	756.6	1347 mV	4.8	4.8	1780
2	1215.6	6733 mV	100.4	105.2	11735
3	2111.1	1508 mV	78.3	183.5	-5835
4	2573.4	3056 mV	99.1	282.6	3348
5	3469.5	29 mV	78.6	361.1	-3378
6	3953.9	7519 mV	114.6	475.7	15464
7	4776.9	1469 mV	69.9	545.6	-7351
8	5178.7	7861 mV	104	649.6	15909
9	5952.3	1552 mV	75.1	724.7	-8155
10	6328.9	7392 mV	113.2	837.9	15507
11	7123	1044 mV	66.6	904.5	-7994
12	7558.2	7280 mV	111	1015.	14329
				5	

Channel Mark	Time	4 Right Foot Value	Area	Total Area	Slope
1	51.5	0 mV	0.2	0.2	0
2	536.1	7895 mV	115.8	116.1	16292
3	1381.8	0 mV	78.7	194.8	-9336
4	1896.4	5063 mV	111	305.8	9838
5	2778.8	2065 mV	89.8	395.6	-3398
6	3263.1	112 mV	103.4	499	-4032
7	4130.9	2309 mV	94.9	593.9	2532
8	4593.1	7397 mV	107	700.8	11009
9	4963.3	971 mV	78.5	779.3	-17355
10	5730.7	8466 mV	137	916.3	9768
11	6492	1406 mV	85.4	1001.	-9273
				7	
12	6924.4	7661 mV	130.5	1132.	14463
				2	

Channel Mark	Time	5 Right Tone Value	Area	Total Area	Slope
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1	676.6	541 mV	37	37	799.5
2	2052.5	29 mV	181	218	-372.1
3	3429.2	0 mV	183.3	401.3	-21.07
4	4804.1	7919 mV	192	593.3	5760
5	6180.8	2729 mV	172.5	765.8	-3770
6	7557.5	4829 mV	179.2	944.9	1525

Channel Mark	Time	6 L Va	eft lue	Tib Area	ial Total	is Area	Anterior Slope
1		1194	15 uV	53	53	12.56	
2		1204	92 uV	0.6	53.7	7700	
3		1214	35 uV	0.5	54.2	-5700	
4		1224	92 uV	0.8	55	5700	
5		1234	230 uV	0.9	55.8	13800	
6		1244	59 uV	3.1	58.9	-17100	
7		1254	4 uV	0.2	59.2	-5500	
8		1264	9 uV	0.2	59.4	500	
9		1274	24 uV	0.2	59.6	1500	
10		1284	25 uV	0.2	59.7	100	
11		1294	9 uV	0.3	60.1	-1600	
12		1304	83 uV	0.3	60.4	7400	
13		1314	54 uV	0.4	60.7	-2900	
14		1324	19 uV	0.2	60.9	-3500	
15		1334	43 uV	0.3	61.2	2400	
16		1344	34 uV	0.1	61.3	-900	
17		1354	9 uV	0.2	61.6	-2500	
18		1364	29 uV	0.2	61.8	2000	
19		1374	9 uV	0.2	62	-2000	
20		1384	24 uV	0.2	62.2	1500	
21		1394	53 uV	0.3	62.5	2900	
22		2550	108 uV	55.8	118.3	47.58	
23		2560	92 uV	0.8	119.1	-1600	
24		2570	0 uV	2	121	-9200	
25		2580	214 uV	1.6	122.7	21400	
26		2590	249 uV	1.5	124.2	3500	
27		2600	220 uV	1.7	125.9	-2900	
28		2610	24 uV	0.6	126.5	-19600	
29		2620	9 uV	0.6	127.1	-1500	
30		2630	39 uV	0.3	127.4	3000	
31		2640	48 uV	0.3	127.7	900	
32		2650	39 uV	0.3	128	-900	
33		2660	19 uV	0.2	128.2	-2000	

34	2670	9 μ V	0.2	128.4	-1000
35	2680	19 μ V	0.2	128.6	1000
36	2690	19 μ V	0.3	128.9	0
37	2700	14 μ V	0.2	129.1	-500
38	2710	0 μ V	0.2	129.3	-1400
39	2720	14 μ V	0.4	129.6	1400
40	2730	9 μ V	0.2	129.8	-500
41	2740	9 μ V	0.2	129.9	0
42	2750	63 μ V	0.4	130.3	5400
43	3911	79 μ V	54.5	184.8	13.78
44	3921	84 μ V	1.4	186.2	500
45	3931	142 μ V	1.3	187.5	5800
46	3941	10 μ V	0.5	188	-13200
47	3951	224 μ V	1.1	189.1	21400
48	3961	239 μ V	2.9	192	1500
49	3971	92 μ V	0.9	193	-14700
50	3981	49 μ V	0.5	193.5	-4300
51	3991	40 μ V	0.3	193.8	-900
52	4001	196 μ V	2.3	196.1	15600
53	4011	59 μ V	1.2	197.2	-13700
54	4021	127 μ V	0.9	198.1	6800
55	4031	186 μ V	2.4	200.5	5900
56	4041	29 μ V	0.6	201	-15700
57	4051	39 μ V	0.7	201.7	1000
58	4061	48 μ V	0.3	202	900
59	4071	14 μ V	0.2	202.3	-3400
60	4081	29 μ V	0.2	202.5	1500
61	4091	19 μ V	0.2	202.7	-1000
62	4101	19 μ V	0.3	202.9	0
63	4111	9 μ V	0.1	203	-1000
64	5217	176 μ V	85.5	288.6	151
65	5227	108 μ V	1.1	289.7	-6800
66	5237	561 μ V	4.3	294	45300
67	5247	15 μ V	1.2	295.1	-54600
68	5257	14 μ V	0.1	295.3	-100
69	5267	53 μ V	0.2	295.4	3900
70	5277	10 μ V	0.3	295.7	-4300
71	5287	14 μ V	0.5	296.2	400
72	5297	24 μ V	0.2	296.4	1000
73	5307	190 μ V	0.5	296.9	16600
74	5317	103 μ V	1.1	298	-8700
75	5327	240 μ V	1.5	299.5	13700
76	5337	234 μ V	2.9	302.5	-600

77	5347	181 uV	0.9 303.4	-5300
78	5357	19 uV	0.5 303.9	-16200
79	5367	20 uV	0.2 304.1	100
80	5377	63 uV	0.2 304.3	4300
81	5387	14 uV	0.4 304.7	-4900
82	5397	43 uV	0.2 304.9	2900
83	5407	185 uV	0.6 305.5	14200
84	5417	35 uV	0.6 306.1	-15000
85	6391	59 uV	65.1 371.2	24.64
86	6401	10 uV	0.2 371.4	-4900
87	6411	157 uV	0.7 372.1	14700
88	6421	102 uV	1.1 373.3	-5500
89	6431	19 uV	0.6 373.9	-8300
90	6441	44 uV	0.9 374.8	2500
91	6451	9 uV	0.3 375.1	-3500
92	6461	58 uV	0.3 375.3	4900
93	6471	14 uV	0.3 375.7	-4400
94	6481	5 uV	0.2 375.9	-900
95	6491	24 uV	0.2 376.1	1900
96	6501	15 uV	0.2 376.4	-900
97	6511	10 uV	0.4 376.8	-500
98	6521	5 uV	0.3 377.1	-500
99	6531	14 uV	0.1 377.3	900
100	6541	9 uV	0.4 377.6	-500
101	6551	34 uV	0.2 377.8	2500
102	6561	69 uV	0.4 378.2	3500
103	6571	14 uV	0.5 378.7	-5500
104	6581	9 uV	0.4 379	-500
105	6591	59 uV	0.2 379.2	5000
106	7562	93 uV	53.6 432.8	35.02
107	7572	347 uV	1.3 434.1	25400
108	7582	64 uV	1 435.1	-28300
109	7592	0 uV	1 436.1	-6400
110	7602	15 uV	0.6 436.7	1500
111	7612	112 uV	0.8 437.6	9700
112	7622	9 uV	0.2 437.8	-10300
113	7632	19 uV	0.2 438	1000
114	7642	34 uV	0.3 438.3	1500
115	7652	30 uV	0.3 438.6	-400
116	7662	24 uV	0.4 438.9	-600
117	7672	24 uV	0.2 439.1	0
118	7682	19 uV	0.5 439.6	-500
119	7692	24 uV	0.2 439.8	500

120	7702	34 uV	0.3	440	1000
121	7712	34 uV	0.6	440.6	0
122	7722	24 uV	0.2	440.8	-1000
123	7732	5 uV	0.2	441	-1900
124	7742	9 uV	0.2	441.1	400
125	7752	48 uV	0.2	441.3	3900
126	7762	24 uV	0.5	441.8	-2400

Channel Mark	Time	7 Ri Va	ght lue	Tib Area	ial Total	is Area	Anterior Slope
1	1194	4 uV	88	88	3.35		
2	1204	0 uV	0.2	88.2	-400		
3	1214	30 uV	0.2	88.4	3000		
4	1224	10 uV	0.1	88.5	-2000		
5	1234	0 uV	0.2	88.7	-1000		
6	1244	5 uV	0.1	88.8	500		
7	1254	4 uV	0.1	88.9	-100		
8	1264	9 uV	0.1	89	500		
9	1274	20 uV	0.1	89.1	1100		
10	1284	5 uV	0.1	89.2	-1500		
11	1294	0 uV	0.1	89.3	-500		
12	1304	14 uV	0.1	89.5	1400		
13	1314	19 uV	0.4	89.9	500		
14	1324	88 uV	0.6	90.5	6900		
15	1334	53 uV	0.7	91.2	-3500		
16	1344	69 uV	0.5	91.7	1600		
17	1354	235 uV	1.7	93.5	16600		
18	1364	102 uV	2	95.5	-13300		
19	1374	25 uV	0.3	95.8	-7700		
20	1384	44 uV	0.5	96.3	1900		
21	1394	54 uV	0.6	96.9	1000		
22	2550	35 uV	105.2	202.1	-16.44		
23	2560	9 uV	0.2	202.3	-2600		
24	2570	39 uV	0.3	202.6	3000		
25	2580	4 uV	0.4	203	-3500		
26	2590	29 uV	0.3	203.3	2500		
27	2600	0 uV	0.2	203.5	-2900		

28	2610	10 uV	0.1	203.6	1000
29	2620	4 uV	0.2	203.8	-600
30	2630	5 uV	0.1	203.9	100
31	2640	0 uV	0.1	204	-500
32	2650	10 uV	0.1	204.1	1000
33	2660	5 uV	0.1	204.2	-500
34	2670	15 uV	0.2	204.3	1000
35	2680	9 uV	0.1	204.4	-600
36	2690	5 uV	0.1	204.5	-400
37	2700	9 uV	0.2	204.7	400
38	2710	30 uV	0.1	204.8	2100
39	2720	5 uV	0.2	205	-2500
40	2730	5 uV	0.4	205.4	0
41	2740	215 uV	1.4	206.8	21000
42	2750	268 uV	2.1	208.9	5300
43	3911	29 uV	85.7	294.6	-205.9
44	3921	59 uV	0.4	295	3000
45	3931	19 uV	0.3	295.3	-4000
46	3941	20 uV	0.4	295.7	100
47	3951	0 uV	0.2	295.9	-2000
48	3961	34 uV	0.2	296.1	3400
49	3971	73 uV	0.4	296.6	3900
50	3981	10 uV	0.4	296.9	-6300
51	3991	30 uV	0.2	297.2	2000
52	4001	30 uV	0.2	297.4	0
53	4011	20 uV	0.1	297.5	-1000
54	4021	40 uV	0.1	297.6	2000
55	4031	35 uV	0.2	297.9	-500
56	4041	5 uV	0.4	298.3	-3000
57	4051	395 uV	1.9	300.1	39000
58	4061	181 uV	1.6	301.7	-21400
59	4071	473 uV	2.6	304.3	29200
60	4081	435 uV	3.8	308.1	-3800
61	4091	48 uV	2.3	310.3	-38700
62	4101	14 uV	1.2	311.5	-3400
63	4111	284 uV	1.3	312.8	27000
64	5217	5 uV	88.2	401	-252.3
65	5227	25 uV	0.3	401.3	2000
66	5237	25 uV	0.2	401.5	0
67	5247	88 uV	0.6	402.1	6300
68	5257	30 uV	0.9	402.9	-5800
69	5267	53 uV	0.8	403.8	2300
70	5277	292 uV	2.8	406.6	23900

71	5287	118 uV	3.7	410.3	-17400
72	5297	108 uV	0.8	411.1	-1000
73	5307	24 uV	0.9	412	-8400
74	5317	48 uV	0.4	412.4	2400
75	5327	98 uV	0.5	412.9	5000
76	5337	214 uV	1.9	414.7	11600
77	5347	269 uV	1.7	416.4	5500
78	5357	87 uV	0.9	417.3	-18200
79	5367	136 uV	1.4	418.7	4900
80	5377	137 uV	1.8	420.5	100
81	5387	54 uV	0.6	421.1	-8300
82	5397	48 uV	0.2	421.3	-600
83	5407	68 uV	0.5	421.8	2000
84	5417	205 uV	1.1	422.9	13700
85	6391	25 uV	63.6	486.5	-184.8
86	6401	30 uV	0.8	487.3	500
87	6411	10 uV	0.3	487.6	-2000
88	6421	64 uV	0.4	488	5400
89	6431	34 uV	0.8	488.8	-3000
90	6441	107 uV	0.5	489.3	7300
91	6451	49 uV	0.8	490.1	-5800
92	6461	283 uV	5.2	495.3	23400
93	6471	48 uV	1.9	497.1	-23500
94	6481	137 uV	0.7	497.9	8900
95	6491	79 uV	0.8	498.7	-5800
96	6501	14 uV	1.1	499.7	-6500
97	6511	59 uV	1.4	501.1	4500
98	6521	791 uV	1.8	502.9	73200
99	6531	126 uV	3	506	-66500
100	6541	210 uV	3.1	509	8400
101	6551	9 uV	0.6	509.6	-20100
102	6561	88 uV	0.4	510	7900
103	6571	0 uV	0.6	510.6	-8800
104	6581	229 uV	0.8	511.4	22900
105	6591	0 uV	1.3	512.7	-22900
106	7562	24 uV	63.8	576.5	24.72
107	7572	175 uV	1.1	577.6	15100
108	7582	234 uV	1	578.6	5900
109	7592	14 uV	1	579.7	-22000
110	7602	25 uV	0.9	580.6	1100
111	7612	84 uV	1	581.6	5900
112	7622	9 uV	0.2	581.7	-7500
113	7632	59 uV	0.8	582.5	5000

114	7642	0 uV	0.1	582.6	-5900
115	7652	20 uV	0.2	582.8	2000
116	7662	292 uV	1.8	584.7	27200
117	7672	585 uV	2.9	587.5	29300
118	7682	14 uV	1.5	589	-57100
119	7692	494 uV	1.6	590.6	48000
120	7702	225 uV	3.7	594.3	-26900
121	7712	5 uV	0.7	595	-22000
122	7722	68 uV	0.9	595.9	6300
123	7732	39 uV	0.9	596.8	-2900
124	7742	92 uV	0.9	597.7	5300
125	7752	131 uV	0.8	598.5	3900
126	7762	166 uV	1.7	600.2	3500

Channel		8 Right Ga	strocnemius			
Mark	Time	Va	Iue	Area	Total	Area Slope
	1	1194	88 uV	115.8	115.8	73.7
	2	1204	4 uV	0.3	116.1	-8400
	3	1214	54 uV	0.4	116.6	5000
	4	1224	40 uV	0.4	117	-1400
	5	1234	49 uV	0.5	117.4	900
	6	1244	44 uV	0.4	117.8	-500
	7	1254	15 uV	0.4	118.3	-2900
	8	1264	15 uV	0.4	118.7	0
	9	1274	10 uV	0.4	119.1	-500
	10	1284	10 uV	0.3	119.4	0
	11	1294	25 uV	0.6	120	1500
	12	1304	35 uV	0.3	120.3	1000
	13	1314	142 uV	0.9	121.2	10700
	14	1324	279 uV	1.6	122.8	13700
	15	1334	9 uV	1.6	124.3	-27000
	16	1344	49 uV	0.8	125.1	4000
	17	1354	19 uV	0.7	125.9	-3000
	18	1364	195 uV	2.4	128.3	17600
	19	1374	391 uV	1.5	129.8	19600
	20	1384	136 uV	1.8	131.6	-25500
	21	1394	10 uV	1.4	132.9	-12600

22	2550	30 μ V	103.6	236.6	17.3
23	2560	48 μ V	1	237.5	1800
24	2570	59 μ V	0.6	238.1	1100
25	2580	93 μ V	0.6	238.7	3400
26	2590	157 μ V	0.7	239.4	6400
27	2600	35 μ V	0.6	240.1	-12200
28	2610	44 μ V	0.5	240.5	900
29	2620	44 μ V	0.4	240.9	0
30	2630	54 μ V	0.4	241.3	1000
31	2640	49 μ V	0.5	241.8	-500
32	2650	44 μ V	0.5	242.3	-500
33	2660	44 μ V	0.5	242.7	0
34	2670	44 μ V	0.4	243.1	0
35	2680	44 μ V	0.4	243.5	0
36	2690	40 μ V	0.4	244	-400
37	2700	30 μ V	0.4	244.4	-1000
38	2710	84 μ V	0.5	244.9	5400
39	2720	35 μ V	0.4	245.3	-4900
40	2730	25 μ V	0.3	245.6	-1000
41	2740	44 μ V	0.4	246.1	1900
42	2750	152 μ V	0.4	246.5	10800
43	3911	35 μ V	120.1	366.6	-100.8
44	3921	25 μ V	0.3	366.9	-1000
45	3931	113 μ V	0.5	367.4	8800
46	3941	49 μ V	0.5	367.9	-6400
47	3951	88 μ V	0.5	368.4	3900
48	3961	64 μ V	0.3	368.7	-2400
49	3971	74 μ V	0.5	369.2	1000
50	3981	35 μ V	0.5	369.8	-3900
51	3991	40 μ V	0.3	370.1	500
52	4001	25 μ V	0.6	370.6	-1500
53	4011	30 μ V	0.3	370.9	500
54	4021	49 μ V	0.4	371.4	1900
55	4031	49 μ V	0.5	371.9	0
56	4041	269 μ V	0.9	372.7	22000
57	4051	10 μ V	2.5	375.3	-25900
58	4061	74 μ V	0.5	375.8	6400
59	4071	0 μ V	0.7	376.6	-7400
60	4081	230 μ V	1	377.5	23000
61	4091	9 μ V	0.5	378	-22100
62	4101	49 μ V	0.5	378.4	4000
63	4111	20 μ V	1.7	380.1	-2900
64	5217	157 μ V	134.7	514.9	123.9

65	5227	411 uV	1.3	516.2	25400
66	5237	74 uV	2.2	518.3	-33700
67	5247	123 uV	0.6	519	4900
68	5257	108 uV	0.6	519.6	-1500
69	5267	25 uV	0.5	520.1	-8300
70	5277	73 uV	0.8	520.9	4800
71	5287	54 uV	0.3	521.2	-1900
72	5297	112 uV	1.5	522.7	5800
73	5307	274 uV	1	523.7	16200
74	5317	30 uV	1.2	524.9	-24400
75	5327	108 uV	0.7	525.6	7800
76	5337	10 uV	0.5	526.2	-9800
77	5347	39 uV	0.3	526.5	2900
78	5357	35 uV	1.1	527.5	-400
79	5367	147 uV	0.3	527.9	11200
80	5377	424 uV	4.1	532	27700
81	5387	10 uV	0.6	532.6	-41400
82	5397	69 uV	0.6	533.2	5900
83	5407	63 uV	1	534.2	-600
84	5417	30 uV	0.5	534.7	-3300
85	6391	283 uV	81.7	616.4	259.8
86	6401	126 uV	1.7	618.1	-15700
87	6411	483 uV	3.2	621.3	35700
88	6421	54 uV	2.4	623.7	-42900
89	6431	162 uV	1.1	624.8	10800
90	6441	131 uV	3.6	628.4	-3100
91	6451	59 uV	3	631.4	-7200
92	6461	117 uV	1.8	633.2	5800
93	6471	54 uV	0.8	634	-6300
94	6481	230 uV	1.3	635.3	17600
95	6491	406 uV	2.4	637.7	17600
96	6501	69 uV	2.2	639.9	-33700
97	6511	123 uV	1.6	641.5	5400
98	6521	15 uV	1.3	642.7	-10800
99	6531	64 uV	0.3	643.1	4900
100	6541	59 uV	0.6	643.7	-500
101	6551	64 uV	0.6	644.3	500
102	6561	79 uV	0.7	645	1500
103	6571	220 uV	1.1	646.1	14100
104	6581	35 uV	1.1	647.2	-18500
105	6591	44 uV	1.1	648.4	900
106	7562	35 uV	87.2	735.5	-9.269
107	7572	34 uV	0.4	735.9	-100

108	7582	102 μ V	1.2	737.1	6800
109	7592	15 μ V	0.2	737.3	-8700
110	7602	54 μ V	0.4	737.7	3900
111	7612	44 μ V	0.6	738.3	-1000
112	7622	49 μ V	0.3	738.6	500
113	7632	40 μ V	0.4	739	-900
114	7642	264 μ V	1.3	740.2	22400
115	7652	201 μ V	1.5	741.7	-6300
116	7662	24 μ V	1.3	743	-17700
117	7672	5 μ V	0.7	743.6	-1900
118	7682	59 μ V	0.8	744.5	5400
119	7692	142 μ V	0.5	744.9	8300
120	7702	425 μ V	1.4	746.3	28300
121	7712	112 μ V	3.7	750	-31300
122	7722	4 μ V	1.1	751	-10800
123	7732	40 μ V	1.1	752.2	3600
124	7742	362 μ V	1.7	753.9	32200
125	7752	927 μ V	5.1	759	56500
126	7762	117 μ V	2.8	761.8	-81000

APPENDIX C - Sample Analysis of Timing and Reflex Data

	USIN G 1'	USIN G 2'	USIN G 3'	USIN G 4'	USIN G 5'	AVERA GE	SD
CYCLE DURATION - LEFT	1357. 8	1380.5	1224.8	1150.2		1278.32	109.6007 5 1
CYCLE DURATION - RIGHT	1360. 3	1366.7	1330	1137.6		1298.65	108.5532 9
PERCENT SWING - LEFT	33.80 %	33.49 %	39.55 %	34.93 %		0.35443	0.028064 73 5
PERCENT SWING - RIGHT	35.62 %	37.65 %	36.41 %	40.63 %		0.37580	0.021976 04 3
TONE - LEFT	1355. 2	2731.3	4105.5	5483.5	6858.2	LTN- RTN	POSITIV E
HEEL STRIKE - LEFT	1215. 6	2573.4	3953.9	5178.7	6328.9	LHS- LTO	<700
TONE - RIGHT	676.6	2052.5	3429.2	4804.1	6180.8		
HEEL STRIKE - RIGHT	536.1	1896.4	3263.1	4593.1	5730.7	RHS- RTO	<700
STIMULUS	1194. 3	2550.2	3911.2	5217.2	6390.5	STIM- LTO	POSITIV E
PHASE LAG - TONE	0.986 4089	0.9861 262	0.9837 806	0.9869 979		0.98582	0.001412 84 6
PHASE LAG - FEET	0.999 0443	0.9907 075	1.0387 97	1.0295 359		1.01452	0.023247 12 8
STIMULUS DELAY (ms)	437.7	439.1	441.7	440.3	438.2	439.4	1.621727 5
STIMULUS DELAY (%)	95.36 %	94.98 %	91.18 %	109.58 %	116.36 %	1.01492	0.108701 96 3
STIMULUS OFFSET	-4.0	-2.6	0.0	-1.4	-3.5		
TIMING ERROR - LEFT	139.6	157.9	151.6	304.8	529.3	256.64	166.6914 9
TIMING ERROR - RIGHT	140.5	156.1	166.1	211	450.1	224.76	128.6685 6
REF ITA @	10	0.6	0.8	1.4	0.2	1.3	0.725 0.457347 4

							Dual SI	
	20	0.5	2	1.3	0.7	1	1.05 0.665832	8
	30	0.8	1.6	0.5	1.1	1	1.125 0.340343	
	40	0.9	1.5	1.1	0.6	0.6	0.9 0.424264	1
	50	3.1	1.7	2.9	0.9	0.8	1.625 1.062622	5
	60	0.2	0.6	0.9	0.3	0.2	0.325 0.189296	9
	70	0.2	0.6	0.5	0.3	0.2	0.325 0.189296	9
	80	0.2	0.3	0.3	0.3	0.3	0.275 0.05	
	90	0.2	0.3	2.3	0.2	0.3	0.25 0.057735	
	100	0.3	0.3	1.2	0.2	0.4	0.3 0.081649	7
	110	0.3	0.2	0.9	0.2	0.2	0.225 0.05	
	120	0.4	0.2	2.4	0.4	0.5	0.375 0.125830	6
	130	0.2	0.2	0.6	0.3	0.2	0.225 0.05	
	140	0.3	0.3	0.7	0.1	0.3	0.25 0.1	
	150	0.1	0.2	0.3	0.4	0.6	0.325 0.221735	6
	160	0.2	0.2	0.2	0.2	0.2	0.2 0	
	170	0.2	0.4	0.2	0.4	0.2	0.3 0.115470	1
	180	0.2	0.2	0.2	0.5	0.2	0.275 0.15	
	190	0.2	0.2	0.3	0.4	0.2	0.25 0.1	
	200	0.3	0.4	0.1	0.2	0.5	0.35 0.129099	4
REF CTA @	10	0.2	0.2	0.4	0.3	0.8	0.375 0.287228	1
LEFT DURATION CHECK:::	20	0.2	0.3	0.3	0.2	0.3	0.25 0.057735	
	459 30	0.1	0.4	0.4	0.6	0.4	0.375 0.206155	3
	895.5 40	0.2	0.3	0.2	0.9	0.8	0.55 0.351188	5

								Dual 52
	462.3	50	0.1	0.2	0.2	0.8	0.5	0.4 0.3162278
	896.1	60	0.1	0.1	0.4	2.8	0.8	0.95 1.2767145
	484.4	70	0.1	0.2	0.4	3.7	5.2	2.3 2.5573424
	823	80	0.1	0.1	0.2	0.8	1.9	0.725 0.85
	401.8	90	0.1	0.1	0.2	0.9	0.7	0.45 0.4123106
	773.6	10	0.1	0.1	0.1	0.4	0.8	0.35 0.3316625
	376.6	11	0.1	0.1	0.1	0.5	1.1	0.45 0.4725816
	794.1	12	0.4	0.2	0.2	1.9	1.4	0.975 0.8098354
	435.2	13	0.6	0.1	0.4	1.7	1.8	1.05 0.8346656
	14	0	0.7	0.1	1.9	0.9	3	1.175 1.263263
FIRST DURATION SHOULD BE LOWER!!!	15	0	0.5	0.2	1.6	1.4	3.1	1.3 1.3038405
	16	0	1.7	0.1	2.6	1.8	0.6	1.05 0.8346656
	17	0	2	0.2	3.8	0.6	0.4	0.8 0.8164966
	18	0	0.3	0.4	2.3	0.2	0.6	0.375 0.1707825
	19	0	0.5	1.4	1.2	0.5	0.8	0.8 0.4242641
	20	0	0.6	2.1	1.3	1.1	1.3	1.275 0.6238322
REF CGS @	10		0.3	1	0.3	1.3	1.7	1.075 0.5909033
RIGHT DURATION CHECK:::	20		0.4	0.6	0.5	2.2	3.2	1.6 1.3366625
	484.6	30	0.4	0.6	0.5	0.6	2.4	1 0.9380832
	845.7	40	0.5	0.7	0.5	0.6	1.1	0.725 0.2629956
	514.6	50	0.4	0.6	0.3	0.5	3.6	1.275 1.552149
	882.4	60	0.4	0.5	0.5	0.8	3	1.175 1.2284814
	484.3	70	0.4	0.4	0.5	0.3	1.8	0.725 0.718215

								Dual
								53
								4
867.8	80	0.4	0.4	0.3	1.5	0.8	0.775 0.518812	7
462.2	90	0.3	0.5	0.6	1	1.3	0.775 0.457347	4
370.2	10	0.6	0.5	0.3	1.2	2.4	1.175 0.873212	5
767.4	11	0.3	0.5	0.4	0.7	2.2	0.925 0.865544	1
761.3	12	0.9	0.4	0.5	0.5	1.6	0.85 0.544671	2
432.4	13	1.6	0.4	0.9	0.3	1.3	0.9 0.648074	1
	14	1.6	0.4	2.5	1.1	0.3	0.85 0.613731	8
FIRST DURATION	15	0.8	0.4	0.5	0.3	0.6	0.525 0.221735	6
SHOULD	16	0.7	0.5	0.7	4.1	0.6	1.475 1.751903	7
BE LOWER!!!	17	2.4	0.4	1	0.6	0.7	1.025 0.925112	6
	18	1.5	0.3	0.5	0.6	1.1	0.875 0.531507	3
	19	1.8	0.4	0.5	1	1.1	1.075 0.573730	5
	20	1.4	0.4	1.7	0.5	1.1	0.85 0.479583	2

APPENDIX D - SAS Program for ANOVA's

```
DATA NEWDATA;
OPTIONS PS=120;
INPUT SUBJ COND TRIAL STIMDEL LTIMERR RTIMERR REFA REFB
REFC@;
OUTPUT;

CARDS;

1      5      1      1      150      .      6.15      -
6.95   8.05
1      5      2      1      129      .      0.25      -
0.40   3.20
1      5      3      1      31       .      -1.35     -
1.95   -9.95
1      6      1      1      93       .      -4.00     -
1.35   -11.85
1      6      2      1      133      .      1.85      -
6.30   9.35
1      7      1      1      87       .      -1.40     -
1.15   -3.80
```

						Dual	
						55	
1	7	2	1	5	.	-0.70	-
4.40	6.60						
1	7	3	1	13	.	-0.05	1.10
18.40							
1	8	1	1	213	.	-0.85	0.80
3.30							
1	8	2	1	52	.	0.20	-
1.25	-7.10						
1	8	3	1	159	.	-4.15	0.05
0.45							
1	9	1	1	102	.	4.35	-
0.25	-3.75						
1	9	2	1	97	.	0.00	-
0.65	-5.65						
1	9	3	1	112	.	-1.10	0.80
3.15							
1	1	1	1	91	.	3.15	-
0.65	-1.70						
1	1	2	1	128	.	2.80	-
0.40	-3.60						
1	1	3	1	105	.	1.25	-
0.25	-2.55						
2	5	1	2	176	.	1.40	-
2.30	-11.75						

							Dual 56	
2	5	2	2	149	-58	-2.90	-	
0.35	5.50							
2	5	3	2	84	-53	-0.20	-	
1.10	-12.65							
2	6	1	2	39	.	1.10	-	
2.85	-16.05							
2	6	2	2	82	-6	-0.95	0.90	
	-21.45							
2	6	3	2	115	9	-0.90	-	
1.45	-1.10							
2	7	1	2	93	.	-3.15	-	
0.45	-1.60							
2	7	2	2	75	25	2.70	-	
2.30	-5.00							
2	7	3	2	49	-38	-3.90	1.55	
	0.50							
2	8	1	2	60	.	-4.25	0.15	
	-0.75							
2	9	1	2	218	.	7.50	-	
0.45	-0.75							
2	1	1	2	133	.	-10.90	-	
3.15	-0.95							
2	1	2	2	104	.	0.55	-	
1.75	0.65							

							Dual 57
2	1	3	2	149	148	6.05	8.00
	0.55						
3	6	2	1	278	.	7.80	0.25
	4.75						
3	6	3	1	168	.	4.00	-
1.20	-0.30						
3	8	2	1	36	.	0.25	-
1.25	-0.40						
3	8	3	1	-229	.	3.45	-
0.75	-0.40						
3	1	3	1	303	.	5.80	-
0.75	-11.25						
4	5	2	2	173	-55	1.65	0.00
	-6.70						
4	5	3	2	130	-46	1.70	-
0.65	-5.15						
4	6	2	2	236	29	-11.85	-
6.95	-14.45						
4	6	3	2	130	-8	-3.05	-
2.90	2.90						
4	7	2	2	131	-8	5.60	-
0.50	-1.40						
4	7	3	2	186	86	2.00	0.25
	-0.80						

						Dual ⁵⁸	
4	8	2	2	228	117	-5.50	-
0.30	-3.20						
4	8	3	2	75	-53	-1.90	0.20
	-1.20						
4	9	2	2	-111	-183	8.35	-
0.55	-2.80						
4	9	3	2	26	-29	-2.80	-
0.80	-7.70						
4	1	2	2	40	90	5.70	-
0.35	-3.85						
4	1	3	2	58	51	-3.00	0.95
	-0.20						
5	5	1	1	259	.	2.25	-
1.95	2.15						
5	6	1	1	211	.	0.35	2.95
	16.00						
5	6	2	1	91	.	-0.85	0.25
	-1.75						
5	6	3	1	144	.	1.95	-
0.80	1.65						
5	7	1	1	98	.	2.90	-
3.35	0.70						
5	7	2	1	208	.	-1.65	0.50
	2.05						

							Dual 59	
5	7	3	1	143	.	1.70	-	
1.45	1.25							
5	8	1	1	167	.	1.55	2.65	
0.25								
5	8	2	1	162	.	-0.45	-	
2.25	-1.25							
5	8	3	1	101	.	-4.40	-	
1.05	-5.25							
5	9	1	1	-46	.	1.10	-	
1.75	2.90							
5	9	2	1	50	.	-0.40	-	
3.00	0.95							
5	9	3	1	15	.	-1.70	0.10	
1.20								
5	1	1	1	141	.	-2.65	-	
10.30	-3.15							
6	5	1	2	164	0	-4.10	-	
1.60	-0.70							
6	5	2	2	146	41	-2.65	-	
0.75	-3.60							
6	5	3	2	107	-18	-0.90	-	
0.60	2.60							
6	6	1	2	98	0	-0.05	0.65	
4.75								

							Dual 60
6	6	2	2	133	107	-6.55	1.15
0.00							
6	6	3	2	87	72	0.25	-
0.05	0.00						
6	7	1	2	24	0	-0.55	-
0.05	3.25						
6	7	2	2	-89	-85	-0.65	-
2.00	6.10						
6	7	3	2	67	87	-1.20	-
1.30	2.55						
6	8	1	2	28	.	5.70	-
0.05	-2.70						
6	8	2	2	-6	30	1.45	-
0.05	-3.55						
6	8	3	2	98	100	4.40	-
1.55	-5.25						
6	9	1	2	204	.	-1.65	0.25
1.70							
6	9	2	2	210	255	-4.50	0.15
0.75							
6	9	3	2	-209	157	-4.20	-
0.40	-2.75						
6	1	1	2	159	.	-0.95	-
0.30	-0.30						

							Dual 61	
6	1	2	2	102	127	9.05	-	
0.30	1.35							
6	1	3	2	135	154	-11.15	6.70	
0.05								
7	5	1	1	352	.	-2.25	-	
4.20	-4.60							
7	5	2	1	211	.	-3.45	-	
4.30	8.30							
7	5	3	1	181	.	3.60	-	
12.85	-10.65							
7	6	1	1	188	.	0.60	-	
1.20	6.85							
7	6	2	1	26	.	-7.80	1.60	
0.00								
7	7	1	1	279	.	1.90	-	
3.60	-4.25							
7	8	1	1	267	.	-7.05	0.05	
-6.75								
7	9	1	1	270	.	-4.30	-	
1.60	8.60							
7	1	1	1	115	.	-2.75	1.60	
-4.00								
7	1	2	1	149	.	-7.15	-	
1.85	6.55							

						Dual 62	
7	1	3	1	183	.	-0.10	-
4.10	0.00						
8	5	1	2	179	.	7.30	0.60
	-3.70						
8	6	1	2	292	.	0.80	-
1.10	-0.40						
8	7	1	2	114	.	-0.10	-
0.95	-2.25						
8	8	1	2	131	.	-3.35	1.90
	-0.65						
8	9	1	2	80	.	-1.30	-
1.25	0.00						
8	1	1	2	133	.	-8.05	2.35
	0.85						
9	5	1	2	265	.	2.75	1.00
	1.85						
9	6	1	2	203	.	6.05	1.05
	-6.40						
9	7	1	2	282	.	-1.95	-
0.80	-2.00						
9	8	1	2	-55	.	-3.65	-
0.50	-2.60						
9	9	1	2	101	.	0.45	1.20
	-0.90						

							Dual	
							63	
9	1	1	2	157	.	0.40	-	
5.80	-5.60							

```
PROC SORT;
BY COND TRIAL STIMDEL;
RUN;
```

```
PROC PRINT;
RUN;
```

```
PROC MEANS MEAN STD N;
BY COND;
VAR LTIMERR RTIMERR REFA REFB REFC;
RUN;
```

```
PROC SORT;
BY TRIAL COND STIMDEL;
RUN;
```

```
PROC MEANS MEAN STD N;
BY TRIAL;
VAR LTIMERR RTIMERR REFA REFB REFC;
RUN;
```

```
PROC SORT;  
BY STIMDEL COND TRIAL;  
RUN;
```

```
PROC MEANS MEAN STD N;  
BY STIMDEL;  
VAR LTIMERR RTIMERR REFA REFB REFC;  
RUN;
```

```
PROC SORT;  
BY COND TRIAL STIMDEL;  
RUN;
```

```
PROC MEANS MEAN STD N;  
BY COND TRIAL;  
VAR LTIMERR RTIMERR REFA REFB REFC;  
RUN;
```

```
PROC SORT;  
BY COND STIMDEL TRIAL;  
RUN;
```

```
PROC MEANS MEAN STD N;
```

```
BY COND STIMDEL;  
VAR LTIMERR RTIMERR REFA REFB REFC;  
RUN;
```

```
PROC SORT;  
BY TRIAL STIMDEL COND;  
RUN;
```

```
PROC MEANS MEAN STD N;  
BY TRIAL STIMDEL;  
VAR LTIMERR RTIMERR REFA REFB REFC;  
RUN;
```

```
proc sort;  
by cond trial stimdel;  
run;
```

```
proc means mean std n;  
by cond trial stimdel;  
var ltimerr rtimerr refa refb refc;  
run;
```

```
*anova using left timing error;
```

```
PROC glm;

CLASS SUBJ COND TRIAL STIMDEL;

MODEL  LTIMERR  =  COND  TRIAL  STIMDEL  SUBJ(STIMDEL)
STIMDEL*COND COND*SUBJ(STIMDEL)

STIMDEL*TRIAL          COND*TRIAL          TRIAL*SUBJ(STIMDEL)
STIMDEL*COND*TRIAL COND*TRIAL*SUBJ(STIMDEL);

TEST H=COND STIMDEL*COND E=COND*SUBJ(STIMDEL);

TEST H=TRIAL STIMDEL*TRIAL E=TRIAL*SUBJ(STIMDEL);

TEST H=STIMDEL E=SUBJ(STIMDEL);

TEST          H=COND*TRIAL          STIMDEL*COND*TRIAL          E=
COND*TRIAL*SUBJ(STIMDEL);

.

MEANS COND / TUKEY E=COND*SUBJ(STIMDEL);
MEANS TRIAL / TUKEY E=TRIAL*SUBJ(STIMDEL);
MEANS STIMDEL / TUKEY E=SUBJ(STIMDEL);
RUN;
```

* anova using reflex a (ipsi tid ant);

PROC glm;

CLASS SUBJ COND TRIAL STIMDEL;

MODEL REFA = COND TRIAL STIMDEL SUBJ(STIMDEL) STIMDEL*COND
COND*SUBJ(STIMDEL)

STIMDEL*TRIAL COND*TRIAL TRIAL*SUBJ(STIMDEL)

STIMDEL*COND*TRIAL COND*TRIAL*SUBJ(STIMDEL);

TEST H=COND STIMDEL*COND E=COND*SUBJ(STIMDEL);

TEST H=TRIAL STIMDEL*TRIAL E=TRIAL*SUBJ(STIMDEL);

TEST H=STIMDEL E=SUBJ(STIMDEL);

TEST H=COND*TRIAL STIMDEL*COND*TRIAL E=
COND*TRIAL*SUBJ(STIMDEL);

MEANS COND / TUKEY E=COND*SUBJ(STIMDEL);

MEANS TRIAL / TUKEY E=TRIAL*SUBJ(STIMDEL);

MEANS TRIAL / TUKEY E=SUBJ(STIMDEL);

RUN;

* anova using reflex b (contra tib ant);

PROC glm;

CLASS SUBJ COND TRIAL STIMDEL;

MODEL REFB = COND TRIAL STIMDEL SUBJ(STIMDEL) STIMDEL*COND
COND*SUBJ(STIMDEL)

```

STIMDEL*TRIAL          COND*TRIAL          TRIAL*SUBJ(STIMDEL)
STIMDEL*COND*TRIAL COND*TRIAL*SUBJ(STIMDEL);
TEST H=COND STIMDEL*COND E=COND*SUBJ(STIMDEL);
TEST H=TRIAL STIMDEL*TRIAL E=TRIAL*SUBJ(STIMDEL);
TEST H=STIMDEL E=SUBJ(STIMDEL);
TEST          H=COND*TRIAL          STIMDEL*COND*TRIAL          E=
COND*TRIAL*SUBJ(STIMDEL);
MEANS COND / TUKEY E=COND*SUBJ(STIMDEL);
MEANS TRIAL / TUKEY E=TRIAL*SUBJ(STIMDEL);
MEANS STIMDEL / TUKEY E=SUBJ(STIMDEL);
RUN;

```

```

* anova using reflex c (contra gast);

```

```

PROC glm;
CLASS SUBJ COND TRIAL STIMDEL;
MODEL REFC = COND TRIAL STIMDEL SUBJ(STIMDEL) STIMDEL*COND
COND*SUBJ(STIMDEL)
STIMDEL*TRIAL          COND*TRIAL          TRIAL*SUBJ(STIMDEL)
STIMDEL*COND*TRIAL COND*TRIAL*SUBJ(STIMDEL);
TEST H=COND STIMDEL*COND E=COND*SUBJ(STIMDEL);
TEST H=TRIAL STIMDEL*TRIAL E=TRIAL*SUBJ(STIMDEL);
TEST H=STIMDEL E=SUBJ(STIMDEL);
TEST          H=COND*TRIAL          STIMDEL*COND*TRIAL          E=

```

```
COND*TRIAL*SUBJ(STIMDEL);  
MEANS COND / TUKEY E=COND*SUBJ(STIMDEL);  
MEANS TRIAL / TUKEY E=TRIAL*SUBJ(STIMDEL);  
MEANS STIMDEL / TUKEY E=SUBJ(STIMDEL);  
RUN;
```


APPENDIX E - SAS Output for ANOVA's

The SAS System 09:31 Wednesday, October 30, 1996 153

OBS	SUBJ	COND	TRIAL	STIMDEL	LTIMERR
RTIMERR	REFA	REFB	REFC		
1	1	1	1	1	91
.	3.15	-0.65	-1.70		
2	5	1	1	1	141
.	-2.65	-10.30	-3.15		
3	7	1	1	1	115
.	-2.75	1.60	-4.00		
4	2	1	1	2	133
.	-10.90	-3.15	-0.95		
5	6	1	1	2	159
.	-0.95	-0.30	-0.30		
6	8	1	1	2	133
.	-8.05	2.35	0.85		
7	9	1	1	2	157
.	0.40	-5.80	-5.60		
8	1	1	2	1	128
.	2.80	-0.40	-3.60		
9	7	1	2	1	149
.	-7.15	-1.85	6.55		
10	2	1	2	2	104
.	0.55	-1.75	0.65		
11	4	1	2	2	40
90	5.70	-0.35	-3.85		
12	6	1	2	2	102
127	9.05	-0.30	1.35		
13	1	1	3	1	105
.	1.25	-0.25	-2.55		
14	3	1	3	1	303
.	5.80	-0.75	-11.25		
15	7	1	3	1	183
.	-0.10	-4.10	0.00		
16	2	1	3	2	149
148	6.05	8.00	0.55		
17	4	1	3	2	58
51	-3.00	0.95	-0.20		
18	6	1	3	2	135
154	-11.15	6.70	0.05		

19	1	5	1	1	150	
.	6.15	-6.95	8.05			
20	5	5	1	1	259	
.	2.25	-1.95	2.15			
21	7	5	1	1	352	
.	-2.25	-4.20	-4.60			
22	2	5	1	2	176	
.	1.40	-2.30	-11.75			
23	6	5	1	2	164	
0	-4.10	-1.60	-0.70			
24	8	5	1	2	179	
.	7.30	0.60	-3.70			
25	9	5	1	2	265	
.	2.75	1.00	1.85			
26	1	5	2	1	129	
.	0.25	-0.40	3.20			
27	7	5	2	1	211	
.	-3.45	-4.30	8.30			
28	2	5	2	2	149	-
58	-2.90	-0.35	5.50			
29	4	5	2	2	173	-
55	1.65	0.00	-6.70			
30	6	5	2	2	146	
41	-2.65	-0.75	-3.60			
31	1	5	3	1	31	
.	-1.35	-1.95	-9.95			
32	7	5	3	1	181	
.	3.60	-12.85	-10.65			
33	2	5	3	2	84	-
53	-0.20	-1.10	-12.65			
34	4	5	3	2	130	-
46	1.70	-0.65	-5.15			
35	6	5	3	2	107	-
18	-0.90	-0.60	2.60			
36	1	6	1	1	93	
.	-4.00	-1.35	-11.85			
37	5	6	1	1	211	
.	0.35	2.95	16.00			
38	7	6	1	1	188	
.	0.60	-1.20	6.85			
39	2	6	1	2	39	
.	1.10	-2.85	-16.05			
40	6	6	1	2	98	
0	-0.05	0.65	4.75			
41	8	6	1	2	292	
.	0.80	-1.10	-0.40			
42	9	6	1	2	203	
.	6.05	1.05	-6.40			

	43	1	6	2	1	133
.		1.85	-6.30	9.35		
	44	3	6	2	1	278
.		7.80	0.25	4.75		
	45	5	6	2	1	91
.		-0.85	0.25	-1.75		
	46	7	6	2	1	26
.		-7.80	1.60	0.00		
	47	2	6	2	2	82
-6		-0.95	0.90	-21.45		
	48	4	6	2	2	236
29		-11.85	-6.95	-14.45		
	49	6	6	2	2	133
107		-6.55	1.15	0.00		
	50	3	6	3	1	168
.		4.00	-1.20	-0.30		
	51	5	6	3	1	144
.		1.95	-0.80	1.65		
	52	2	6	3	2	115
9		-0.90	-1.45	-1.10		
	53	4	6	3	2	130
-8		-3.05	-2.90	2.90		
	54	6	6	3	2	87
72		0.25	-0.05	0.00		
	55	1	7	1	1	87
.		-1.40	-1.15	-3.80		
	56	5	7	1	1	98
.		2.90	-3.35	0.70		
	57	7	7	1	1	279
.		1.90	-3.60	-4.25		
	58	2	7	1	2	93
.		-3.15	-0.45	-1.60		
	59	6	7	1	2	24
0		-0.55	-0.05	3.25		
	60	8	7	1	2	114
.		-0.10	-0.95	-2.25		
	61	9	7	1	2	282
.		-1.95	-0.80	-2.00		
	62	1	7	2	1	5
.		-0.70	-4.40	6.60		
	63	5	7	2	1	208
.		-1.65	0.50	2.05		
	64	2	7	2	2	75
25		2.70	-2.30	-5.00		
	65	4	7	2	2	131
-8		5.60	-0.50	-1.40		
	66	6	7	2	2	-89
85		-0.65	-2.00	6.10		

-

						Dual 73
67	1	7	3	1	13	
.	-0.05	1.10	18.40			
68	5	7	3	1	143	
.	1.70	-1.45	1.25			
69	2	7	3	2	49	-
38	-3.90	1.55	0.50			
70	4	7	3	2	186	
86	2.00	0.25	-0.80			
71	6	7	3	2	67	
87	-1.20	-1.30	2.55			
72	1	8	1	1	213	
.	-0.85	0.80	3.30			
73	5	8	1	1	167	
.	1.55	2.65	0.25			
74	7	8	1	1	267	
.	-7.05	0.05	-6.75			
75	2	8	1	2	60	
.	-4.25	0.15	-0.75			
76	6	8	1	2	28	
.	5.70	-0.05	-2.70			
77	8	8	1	2	131	
.	-3.35	1.90	-0.65			
78	9	8	1	2	-55	
.	-3.65	-0.50	-2.60			
79	1	8	2	1	52	
.	0.20	-1.25	-7.10			
80	3	8	2	1	36	
.	0.25	-1.25	-0.40			
81	5	8	2	1	162	
.	-0.45	-2.25	-1.25			
82	4	8	2	2	228	
117	-5.50	-0.30	-3.20			
83	6	8	2	2	-6	
30	1.45	-0.05	-3.55			
84	1	8	3	1	159	
.	-4.15	0.05	0.45			
85	3	8	3	1	-229	
.	3.45	-0.75	-0.40			
86	5	8	3	1	101	
.	-4.40	-1.05	-5.25			
87	4	8	3	2	75	-
53	-1.90	0.20	-1.20			
88	6	8	3	2	98	
100	4.40	-1.55	-5.25			
89	1	9	1	1	102	
.	4.35	-0.25	-3.75			
90	5	9	1	1	-46	
.	1.10	-1.75	2.90			

						Dual 74
91	7	9	1	1	270	
.	-4.30	-1.60	8.60			
92	2	9	1	2	218	
.	7.50	-0.45	-0.75			
93	6	9	1	2	204	
.	-1.65	0.25	1.70			
94	8	9	1	2	80	
.	-1.30	-1.25	0.00			
95	9	9	1	2	101	
.	0.45	1.20	-0.90			
96	1	9	2	1	97	
.	0.00	-0.65	-5.65			
97	5	9	2	1	50	
.	-0.40	-3.00	0.95			
98	4	9	2	2	-111	-
183	8.35	-0.55	-2.80			
99	6	9	2	2	210	
255	-4.50	0.15	0.75			
100	1	9	3	1	112	
.	-1.10	0.80	3.15			
101	5	9	3	1	15	
.	-1.70	0.10	1.20			
102	4	9	3	2	26	-
29	-2.80	-0.80	-7.70			
103	6	9	3	2	-209	
157	-4.20	-0.40	-2.75			

The SAS System

09:31 Wednesday, October 30, 1996 154

----- COND=1 -----

Dev	N	Variable	Mean	Std

55.4131541	18	LTIMERR	132.5000000	
43.2145809	5	RTIMERR	114.0000000	
5.8412530	18	REFA	-0.6638889	
4.1043825	18	REFB	-0.5750000	
3.6563905	18	REFC	-1.5083333	

----- COND=5 -----

Dev	N	Variable	Mean	Std
73.9159399	17	LTIMERR	169.7647059	
37.0045042	7	RTIMERR	-27.0000000	
3.2708888	17	REFA	0.5441176	
3.3791124	17	REFB	-2.2558824	
6.7784612	17	REFC	-2.2235294	

----- COND=6 -----

Dev	N	Variable	Mean	Std
74.4037901	19	LTIMERR	144.5789474	
44.2869431	7	RTIMERR	29.0000000	
4.6446284	19	REFA	-0.5921053	
2.4987131	19	REFB	-0.9131579	
9.1869847	19	REFC	-1.4473684	

----- COND=7 -----

Dev	N	Variable	Mean	Std

		LTIMERR	103.8235294	
96.6987819	17	RTIMERR	9.5714286	
62.8247752	7	REFA	0.0882353	
2.4201323	17	REFB	-1.1117647	
1.6366438	17	REFC	1.1941176	
5.5361562	17			

----- COND=8 -----

Dev	N	Variable	Mean	Std

		LTIMERR	87.4705882	
118.4441417	17	RTIMERR	48.5000000	
77.4359951	4	REFA	-1.0911765	
3.6383047	17	REFB	-0.1882353	
1.2077264	17	REFC	-2.1794118	
2.7693105	17			

----- COND=9 -----

Dev	N	Variable	Mean	Std

129.0458390	15	LTIMERR	74.6000000
194.9393068	4	RTIMERR	50.0000000
3.9568867	15	REFA	-0.0133333
1.0578730	15	REFB	-0.5466667
3.9500211	15	REFC	-0.3366667

The SAS System

09:31 Wednesday, October 30, 1996 155

----- TRIAL=1 -----

Dev	N	Variable	Mean	Std
90.2519026	42	LTIMERR	150.3571429	
0	3	RTIMERR	0	
3.9631571	42	REFA	-0.2738095	
2.5392928	42	REFB	-1.0166667	
5.5365269	42	REFC	-1.0166667	

----- TRIAL=2 -----

Dev	N	Variable	Mean	Std
89.6092953	31	LTIMERR	108.3225806	
104.7253551	15	RTIMERR	28.4000000	

Dual
78

4.7462509	31	REFA	-0.3161290
2.0088032	31	REFB	-1.2064516
6.3819765	31	REFC	-0.9564516

----- TRIAL=3 -----

Dev	N	Variable	Mean	Std
103.7881574	30	LTIMERR	90.5333333	
77.2698464	16	RTIMERR	38.6875000	
3.5957254	30	REFA	-0.3300000	
3.2955844	30	REFB	-0.5416667	
5.8004449	30	REFC	-1.3966667	

The SAS System

09:31 Wednesday, October 30, 1996 156

----- STIMDEL=1 -----

Dev	N	Variable	Mean	Std
101.5508923	47	LTIMERR	132.3617021	
.	0	RTIMERR	.	
3.3623029	47	REFA	-0.0287234	
2.9489885	47	REFB	-1.6340426	

```

6.3480968    47          REFC          0.2702128
-----
-----
----- STIMDEL=2 -----
-----

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Dev	N	Variable	Mean	Std
92.3651703	56	LTIMERR	110.1428571	
86.5203808	34	RTIMERR	30.7352941	
4.6087987	56	REFA	-0.5330357	
2.1965570	56	REFB	-0.3491071	
5.1163222	56	REFC	-2.2669643	

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The SAS System
09:31 Wednesday, October 30, 1996 157
----- COND=1 TRIAL=1 ----
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Dev	N	Variable	Mean	Std
23.8167608	7	LTIMERR	132.7142857	
.	0	RTIMERR	.	
4.8580199	7	REFA	-3.1071429	
4.4818948	7	REFB	-2.3214286	
2.2503439	7	REFC	-2.1214286	

----- COND=1 TRIAL=2 ----

Dev	N	Variable	Mean	Std
40.9243204	5	LTIMERR	104.6000000	
26.1629509	2	RTIMERR	108.5000000	
6.1171276	5	REFA	2.1900000	
0.7957701	5	REFB	-0.9300000	
4.2628629	5	REFC	0.2200000	

----- COND=1 TRIAL=3 ----

Dev	N	Variable	Mean	Std
83.7036439	6	LTIMERR	155.5000000	
57.8129167	3	RTIMERR	117.6666667	
6.4018292	6	REFA	-0.1916667	
4.6621258	6	REFB	1.7583333	
4.5493589	6	REFC	-2.2333333	

----- COND=5 TRIAL=1 ----

Dev	N	Variable	Mean	Dual 81 Std
73.7331094	7	LTIMERR	220.7142857	
.	1	RTIMERR	0	
4.1136822	7	REFA	1.9285714	
2.7408940	7	REFB	-2.2000000	
6.2641459	7	REFC	-1.2428571	

----- COND=5 TRIAL=2 -----

Dev	N	Variable	Mean	Std
31.7616120	5	LTIMERR	161.6000000	
56.3116329	3	RTIMERR	-24.0000000	
2.2381912	5	REFA	-1.4200000	
1.7753169	5	REFB	-1.1600000	
6.2899126	5	REFC	1.3400000	

----- COND=5 TRIAL=3 -----

Dev	N	Variable	Mean	Std
55.4734171	5	LTIMERR	106.6000000	

18.5202592	3	RTIMERR	-39.0000000
2.0553588	5	REFA	0.5700000
5.2936991	5	REFB	-3.4300000
6.1115055	5	REFC	-7.1600000

----- COND=6 TRIAL=1 ---

Dev	N	Variable	Mean	Std
87.2063781	7	LTIMERR	160.5714286	
.	1	RTIMERR	0	
2.9319261	7	REFA	0.6928571	
1.9293164	7	REFB	-0.2642857	
11.2355728	7	REFC	-1.0142857	

----- COND=6 TRIAL=2 ---

Dev	N	Variable	Mean	Std
88.6179601	7	LTIMERR	139.8571429	
57.8475007	3	RTIMERR	43.3333333	
6.6074363	7	REFA	-2.6214286	
3.6737810	7	REFB	-1.3000000	

```

Dual
83
REFC      -3.3642857
10.8222269      7
-----
-----
----- COND=6 TRIAL=3 -----
-----

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Dev	N	Variable	Mean	Std
30.4417477	5	LTIMERR	128.8000000	
42.1465697	3	RTIMERR	24.3333333	
2.6909571	5	REFA	0.4500000	
1.0491663	5	REFB	-1.2800000	
1.6161683	5	REFC	0.6300000	

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The SAS System
09:31 Wednesday, October 30, 1996 158
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----- COND=7 TRIAL=1 -----
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Dev	N	Variable	Mean	Std
100.3308812	7	LTIMERR	139.5714286	
.	1	RTIMERR	0	
2.1302806	7	REFA	-0.3357143	
1.4112220	7	REFB	-1.4785714	
2.6151573	7	REFC	-1.4214286	

----- COND=7 TRIAL=2 -----

Dev	N	Variable	Mean	Std
114.2541028	5	LTIMERR	66.0000000	
56.4476158	3	RTIMERR	-22.6666667	
3.0276641	5	REFA	1.0600000	
1.8716303	5	REFB	-1.7400000	
4.9494444	5	REFC	1.6700000	

----- COND=7 TRIAL=3 -----

Dev	N	Variable	Mean	Std
70.9774612	5	LTIMERR	91.6000000	
71.8818475	3	RTIMERR	45.0000000	
2.4042670	5	REFA	-0.2900000	
1.3659246	5	REFB	0.0300000	
7.9308417	5	REFC	4.3800000	

----- COND=8 TRIAL=1 -----

Dev	N	Variable	Mean	Dual 85 Std
111.9202522	7	LTIMERR	115.8571429	
.	0	RTIMERR	.	
4.2366457	7	REFA	-1.7000000	
1.1531530	7	REFB	0.7142857	
3.0970032	7	REFC	-1.4142857	

----- COND=8 TRIAL=2 -----

Dev	N	Variable	Mean	Std
97.0917092	5	LTIMERR	94.4000000	
61.5182900	2	RTIMERR	73.5000000	
2.7100277	5	REFA	-0.8100000	
0.8772115	5	REFB	-1.0200000	
2.5944653	5	REFC	-3.1000000	

----- COND=8 TRIAL=3 -----

Dev	N	Variable	Mean	Std
153.9714259	5	LTIMERR	40.8000000	

Dev	N	Variable	Mean	Std
108.1873375	2	RTIMERR	23.5000000	
4.1863767	5	REFA	-0.5200000	
0.7395945	5	REFB	-0.6200000	
2.7286902	5	REFC	-2.3300000	

----- COND=9 TRIAL=1 -----

Dev	N	Variable	Mean	Std
106.3558716	7	LTIMERR	132.7142857	
.	0	RTIMERR	.	
3.9598882	7	REFA	0.8785714	
1.0673175	7	REFB	-0.5500000	
3.9158560	7	REFC	1.1142857	

----- COND=9 TRIAL=2 -----

Dev	N	Variable	Mean	Std
133.1678139	4	LTIMERR	61.5000000	
309.7127702	2	RTIMERR	36.0000000	
5.3900178	4	REFA	0.8625000	
1.3719664	4	REFB	-1.0125000	

```

Dual
87
REFC          -1.6875000
3.1536685      4
-----
-----
----- COND=9 TRIAL=3 -----
-----

```

Dev	N	Variable	Mean	Std
137.0425725	4	LTIMERR	-14.0000000	
131.5218613	2	RTIMERR	64.0000000	
1.3625956	4	REFA	-2.4500000	
0.6898067	4	REFB	-0.0750000	
4.7927897	4	REFC	-1.5250000	

```

The SAS System
09:31 Wednesday, October 30, 1996 159
----- COND=1 STIMDEL=1 -----
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Dev	N	Variable	Mean	Std
67.3656070	8	LTIMERR	151.8750000	
.	0	RTIMERR	.	
4.1173360	8	REFA	0.0437500	
3.6883746	8	REFB	-2.0875000	
4.9168624	8	REFC	-2.4625000	

----- COND=1 STIMDEL=2 --

Dev	N	Variable	Mean	Std

40.8629145	10	LTIMERR	117.0000000	
43.2145809	5	RTIMERR	114.0000000	
7.1037236	10	REFA	-1.2300000	
4.1927219	10	REFB	0.6350000	
2.2345084	10	REFC	-0.7450000	

----- COND=5 STIMDEL=1 --

Dev	N	Variable	Mean	Std

101.7248858	7	LTIMERR	187.5714286	
.	0	RTIMERR	.	
3.4358925	7	REFA	0.7428571	
4.1931918	7	REFB	-4.6571429	
7.9623070	7	REFC	-0.5000000	

----- COND=5 STIMDEL=2 --

Dev	N	Variable	Mean	Dual 89 Std
-----		-----		
48.9399859	10	LTIMERR	157.3000000	
37.0045042	7	RTIMERR	-27.0000000	
3.3312869	10	REFA	0.4050000	
0.9764590	10	REFB	-0.5750000	
5.9574510	10	REFC	-3.4300000	
-----		-----		

----- COND=6 STIMDEL=1 -----

Dev	N	Variable	Mean	Std
-----		-----		
74.3874989	9	LTIMERR	148.0000000	
.	0	RTIMERR	.	
4.4780018	9	REFA	0.4333333	
2.5661796	9	REFB	-0.6444444	
7.8375476	9	REFC	2.7444444	
-----		-----		

----- COND=6 STIMDEL=2 -----

Dev	N	Variable	Mean	Std
-----		-----		
78.3003477	10	LTIMERR	141.5000000	

44.2869431	7	RTIMERR	29.0000000	
4.8293691	10	REFA	-1.5150000	
2.5487960	10	REFB	-1.1550000	
8.9896607	10	REFC	-5.2200000	

----- COND=7 STIMDEL=1 -----

Dev	N	Variable	Mean	Std

99.8281857	7	LTIMERR	119.0000000	
.	0	RTIMERR	.	
1.7815523	7	REFA	0.3857143	
2.1070743	7	REFB	-1.7642857	
7.7263310	7	REFC	2.9928571	

----- COND=7 STIMDEL=2 -----

Dev	N	Variable	Mean	Std

98.3619167	10	LTIMERR	93.2000000	
62.8247752	7	RTIMERR	9.5714286	
2.8599922	10	REFA	-0.1200000	
1.1131662	10	REFB	-0.6550000	

3.2267157 10 REFC -0.0650000

----- COND=8 STIMDEL=1 -----

Dev	N	Variable	Mean	Std

144.4934639	9	LTIMERR	103.1111111	
.	0	RTIMERR	.	
3.2986845	9	REFA	-1.2722222	
1.4370108	9	REFB	-0.3333333	
3.6036825	9	REFC	-1.9055556	

09:31 Wednesday, October 30, 1996 160 The SAS System
----- COND=8 STIMDEL=2 -----

Dev	N	Variable	Mean	Std

86.8157943	8	LTIMERR	69.8750000	
77.4359951	4	RTIMERR	48.5000000	
4.2108491	8	REFA	-0.8875000	
0.9573028	8	REFB	-0.0250000	
1.5756518	8	REFC	-2.4875000	

----- COND=9 STIMDEL=1 --

Dev	N	Variable	Mean	Std

98.8849741	7	LTIMERR	85.7142857	
.	0	RTIMERR	.	
2.6546231	7	REFA	-0.2928571	
1.2908100	7	REFB	-0.9071429	
4.7045571	7	REFC	1.0571429	

----- COND=9 STIMDEL=2 --

Dev	N	Variable	Mean	Std

157.1390990	8	LTIMERR	64.8750000	
194.9393068	4	RTIMERR	50.0000000	
5.0126937	8	REFA	0.2312500	
0.7525848	8	REFB	-0.2312500	
2.9311672	8	REFC	-1.5562500	

09:31 Wednesday, October 30, 1996 161

The SAS System

----- TRIAL=1 STIMDEL=1 --

Dev	N	Variable	Mean	Std
95.7808808	18	LTIMERR	168.7222222	
.	0	RTIMERR	.	
3.3808923	18	REFA	-0.0527778	
3.2430985	18	REFB	-1.6805556	
6.6302393	18	REFC	0.2750000	

----- TRIAL=1 STIMDEL=2 -----

Dev	N	Variable	Mean	Std
85.3075850	24	LTIMERR	136.5833333	
0	3	RTIMERR	0	
4.4139842	24	REFA	-0.4395833	
1.7654173	24	REFB	-0.5187500	
4.4570530	24	REFC	-1.9854167	

----- TRIAL=2 STIMDEL=1 -----

Dev	N	Variable	Mean	Std
-----	---	----------	------	-----

77.3600118	15	LTIMERR	117.0000000
.	0	RTIMERR	.
3.7288834	15	REFA	-0.6200000
2.1575008	15	REFB	-1.5633333
4.9892265	15	REFC	1.4666667

----- TRIAL=2 STIMDEL=2 -----

Dev	N	Variable	Mean	Std
101.6275676	16	LTIMERR	100.1875000	
104.7253551	15	RTIMERR	28.4000000	
5.6477687	16	REFA	-0.0312500	
1.8652943	16	REFB	-0.8718750	
6.8447296	16	REFC	-3.2281250	

----- TRIAL=3 STIMDEL=1 -----

Dev	N	Variable	Mean	Std
122.3031947	14	LTIMERR	102.0714286	
.	0	RTIMERR	.	
3.0333675	14	REFA	0.6357143	

3.4636019	14	REFB	-1.6500000
7.4068993	14	REFC	-1.0178571

----- TRIAL=3 STIMDEL=2 -----

Dev	N	Variable	Mean	Std

87.3452680	16	LTIMERR	80.4375000	
77.2698464	16	RTIMERR	38.6875000	
3.9230090	16	REFA	-1.1750000	
2.9070586	16	REFB	0.4281250	
4.1531903	16	REFC	-1.7281250	

The SAS System

09:31 Wednesday, October 30, 1996 162

----- COND=1 TRIAL=1 -----

STIMDEL=1 -----

Dev	N	Variable	Mean	Std

25.0066658	3	LTIMERR	115.6666667	
.	0	RTIMERR	.	
3.3778692	3	REFA	-0.7500000	
6.3218536	3	REFB	-3.1166667	
1.1629703	3	REFC	-2.9500000	

----- COND=1 TRIAL=1
STIMDEL=2 -----

Dev	N	Variable	Mean	Std
14.4568323	4	LTIMERR	145.5000000	
.	0	RTIMERR	.	
5.4654216	4	REFA	-4.8750000	
3.5247931	4	REFB	-1.7250000	
2.8328431	4	REFC	-1.5000000	

----- COND=1 TRIAL=2
STIMDEL=1 -----

Dev	N	Variable	Mean	Std
14.8492424	2	LTIMERR	138.5000000	
.	0	RTIMERR	.	
7.0357125	2	REFA	-2.1750000	
1.0253048	2	REFB	-1.1250000	
7.1771338	2	REFC	1.4750000	

----- COND=1 TRIAL=2
STIMDEL=2 -----

				Dual 97
Dev	N	Variable	Mean	Std

		LTIMERR	82.0000000	
36.3868108	3	RTIMERR	108.5000000	
26.1629509	2	REFA	5.1000000	
4.2816469	3	REFB	-0.8000000	
0.8231039	3	REFC	-0.6166667	
2.8219379	3			

----- COND=1 TRIAL=3
STIMDEL=1 -----

Dev	N	Variable	Mean	Std

		LTIMERR	197.0000000	
99.7396611	3	RTIMERR	.	
.	0	REFA	2.3166667	
3.0912511	3	REFB	-1.7000000	
2.0934421	3	REFC	-4.6000000	
5.8985168	3			

----- COND=1 TRIAL=3
STIMDEL=2 -----

Dev	N	Variable	Mean	Std

49.0000000	3	LTIMERR	114.0000000
57.8129167	3	RTIMERR	117.6666667
8.6039235	3	REFA	-2.7000000
3.7517774	3	REFB	5.2166667
0.3818813	3	REFC	0.1333333

----- COND=5 TRIAL=1
STIMDEL=1 -----

Dev	N	Variable	Mean	Std
101.1055554	3	LTIMERR	253.6666667	
.	0	RTIMERR	.	
4.2035699	3	REFA	2.0500000	
2.5041632	3	REFB	-4.3666667	
6.3297578	3	REFC	1.8666667	

----- COND=5 TRIAL=1
STIMDEL=2 -----

Dev	N	Variable	Mean	Std
46.4542786	4	LTIMERR	196.0000000	
.	1	RTIMERR	0	
4.6945669	4	REFA	1.8375000	

1.6214705	4	REFB	-0.5750000
5.9031771	4	REFC	-3.5750000

----- COND=5 TRIAL=2
STIMDEL=1 -----

Dev	N	Variable	Mean	Std

57.9827561	2	LTIMERR	170.0000000	
.	0	RTIMERR	.	
2.6162951	2	REFA	-1.6000000	
2.7577164	2	REFB	-2.3500000	
3.6062446	2	REFC	5.7500000	

The SAS System
09:31 Wednesday, October 30, 1996 163

----- COND=5 TRIAL=2
STIMDEL=2 -----

Dev	N	Variable	Mean	Std

14.7986486	3	LTIMERR	156.0000000	
56.3116329	3	RTIMERR	-24.0000000	
2.5578311	3	REFA	-1.3000000	
0.3752777	3	REFB	-0.3666667	
6.3411355	3	REFC	-1.6000000	

Dual
100

----- COND=5 TRIAL=3

STIMDEL=1 -----

Dev	N	Variable	Mean	Std

106.0660172	2	LTIMERR	106.0000000	
.	0	RTIMERR	.	
3.5001786	2	REFA	1.1250000	
7.7074639	2	REFB	-7.4000000	
0.4949747	2	REFC	-10.3000000	

----- COND=5 TRIAL=3

STIMDEL=2 -----

Dev	N	Variable	Mean	Std

23.0000000	3	LTIMERR	107.0000000	
18.5202592	3	RTIMERR	-39.0000000	
1.3453624	3	REFA	0.2000000	
0.2753785	3	REFB	-0.7833333	
7.6253415	3	REFC	-5.0666667	

----- COND=6 TRIAL=1

STIMDEL=1 -----

				Dual 101
Dev	N	Variable	Mean	Std

62.5539767	3	LTIMERR	164.0000000	
.	0	RTIMERR	.	
2.5866645	3	REFA	-1.0166667	
2.4404576	3	REFB	0.1333333	
14.1952750	3	REFC	3.6666667	

----- COND=6 TRIAL=1
STIMDEL=2 -----

Dev	N	Variable	Mean	Std

112.1635710	4	LTIMERR	158.0000000	
.	1	RTIMERR	0	
2.7599819	4	REFA	1.9750000	
1.7880972	4	REFB	-0.5625000	
8.9327581	4	REFC	-4.5250000	

----- COND=6 TRIAL=2
STIMDEL=1 -----

Dev	N	Variable	Mean	Std

106.8238425	4	LTIMERR	132.0000000
.	0	RTIMERR	.
6.4698016	4	REFA	0.2500000
3.5573867	4	REFB	-1.0500000
4.9972284	4	REFC	3.0875000

----- COND=6 TRIAL=2
STIMDEL=2 -----

Dev	N	Variable	Mean	Std

78.4495592	3	LTIMERR	150.3333333	
57.8475007	3	RTIMERR	43.3333333	
5.4506880	3	REFA	-6.4500000	
4.6060648	3	REFB	-1.6333333	
10.9385023	3	REFC	-11.9666667	

----- COND=6 TRIAL=3
STIMDEL=1 -----

Dev	N	Variable	Mean	Std

16.9705627	2	LTIMERR	156.0000000	
.	0	RTIMERR	.	
1.4495689	2	REFA	2.9750000	

0.2828427	2	REFB	-1.0000000
1.3788582	2	REFC	0.6750000

----- COND=6 TRIAL=3
STIMDEL=2 -----

Dev	N	Variable	Mean	Std
21.8250620	3	LTIMERR	110.6666667	
42.1465697	3	RTIMERR	24.3333333	
1.6750622	3	REFA	-1.2333333	
1.4250731	3	REFB	-1.4666667	
2.0663978	3	REFC	0.6000000	

The SAS System
09:31 Wednesday, October 30, 1996 164

----- COND=7 TRIAL=1
STIMDEL=1 -----

Dev	N	Variable	Mean	Std
107.8162016	3	LTIMERR	154.6666667	
.	0	RTIMERR	.	
2.2501852	3	REFA	1.1333333	
1.3481469	3	REFB	-2.7000000	
2.7372431	3	REFC	-2.4500000	

----- COND=7 TRIAL=1
STIMDEL=2 -----

Dev	N	Variable	Mean	Std
109.4725993	4	LTIMERR	128.2500000	
.	1	RTIMERR	0	
1.3870683	4	REFA	-1.4375000	
0.4007805	4	REFB	-0.5625000	
2.6137457	4	REFC	-0.6500000	

----- COND=7 TRIAL=2
STIMDEL=1 -----

Dev	N	Variable	Mean	Std
143.5426766	2	LTIMERR	106.5000000	
.	0	RTIMERR	.	
0.6717514	2	REFA	-1.1750000	
3.4648232	2	REFB	-1.9500000	
3.2173359	2	REFC	4.3250000	

----- COND=7 TRIAL=2
STIMDEL=2 -----

Dev	N	Variable	Mean	Std

114.3328474	3	LTIMERR	39.0000000	
56.4476158	3	RTIMERR	-22.6666667	
3.1276988	3	REFA	2.5500000	
0.9643651	3	REFB	-1.6000000	
5.6630381	3	REFC	-0.1000000	

----- COND=7 TRIAL=3
STIMDEL=1 -----

Dev	N	Variable	Mean	Std

91.9238816	2	LTIMERR	78.0000000	
.	0	RTIMERR	.	
1.2374369	2	REFA	0.8250000	
1.8031223	2	REFB	-0.1750000	
12.1268813	2	REFC	9.8250000	

----- COND=7 TRIAL=3
STIMDEL=2 -----

Dev	N	Variable	Mean	Std

74.4468490	3	LTIMERR	100.6666667
71.8818475	3	RTIMERR	45.0000000
2.9535290	3	REFA	-1.0333333
1.4268263	3	REFB	0.1666667
1.6889346	3	REFC	0.7500000

----- COND=8 TRIAL=1
STIMDEL=1 -----

Dev	N	Variable	Mean	Std
50.0533049	3	LTIMERR	215.6666667	
.	0	RTIMERR	.	
4.4377171	3	REFA	-2.1166667	
1.3382202	3	REFB	1.1666667	
5.1527501	3	REFC	-1.0666667	

----- COND=8 TRIAL=1
STIMDEL=2 -----

Dev	N	Variable	Mean	Std
77.1275999	4	LTIMERR	41.0000000	
.	0	RTIMERR	.	
4.7397917	4	REFA	-1.3875000	

Dual
107

1.0523783	4	REFB	0.3750000
1.1273124	4	REFC	-1.6750000

----- COND=8 TRIAL=2
STIMDEL=1 -----

Dev	N	Variable	Mean	Std
68.5954323	3	LTIMERR	83.3333333	
.	0	RTIMERR	.	
0.3905125	3	REFA	0	
0.5773503	3	REFB	-1.5833333	
3.6477162	3	REFC	-2.9166667	

The SAS System

09:31 Wednesday, October 30, 1996 165

----- COND=8 TRIAL=2
STIMDEL=2 -----

Dev	N	Variable	Mean	Std
165.4629868	2	LTIMERR	111.0000000	
61.5182900	2	RTIMERR	73.5000000	
4.9143921	2	REFA	-2.0250000	
0.1767767	2	REFB	-0.1750000	
0.2474874	2	REFC	-3.3750000	

----- COND=8 TRIAL=3
STIMDEL=1 -----

Dev	N	Variable	Mean	Std
209.2876808	3	LTIMERR	10.3333333	
.	0	RTIMERR	.	
4.4617822	3	REFA	-1.7000000	
0.5686241	3	REFB	-0.5833333	
3.0750339	3	REFC	-1.7333333	

----- COND=8 TRIAL=3
STIMDEL=2 -----

Dev	N	Variable	Mean	Std
16.2634560	2	LTIMERR	86.5000000	
108.1873375	2	RTIMERR	23.5000000	
4.4547727	2	REFA	1.2500000	
1.2374369	2	REFB	-0.6750000	
2.8637825	2	REFC	-3.2250000	

----- COND=9 TRIAL=1
STIMDEL=1 -----

		Dual 109	
Dev	N	Variable	Mean Std

158.1054500	3	LTIMERR	108.6666667
.	0	RTIMERR	.
4.3693058	3	REFA	0.3833333
0.8261356	3	REFB	-1.2000000
6.1810867	3	REFC	2.5833333

----- COND=9 TRIAL=1
STIMDEL=2 -----

Dev	N	Variable	Mean Std

70.3295813	4	LTIMERR	150.7500000
.	0	RTIMERR	.
4.2667318	4	REFA	1.2500000
1.0411332	4	REFB	-0.0625000
1.1918997	4	REFC	0.0125000

----- COND=9 TRIAL=2
STIMDEL=1 -----

Dev	N	Variable	Mean Std

33.2340187	2	LTIMERR	73.5000000
.	0	RTIMERR	.
0.2828427	2	REFA	-0.2000000
1.6617009	2	REFB	-1.8250000
4.6669048	2	REFC	-2.3500000

----- COND=9 TRIAL=2
STIMDEL=2 -----

Dev	N	Variable	Mean	Std

226.9812768	2	LTIMERR	49.5000000	
309.7127702	2	RTIMERR	36.0000000	
9.0863221	2	REFA	1.9250000	
0.4949747	2	REFB	-0.2000000	
2.5102291	2	REFC	-1.0250000	

----- COND=9 TRIAL=3
STIMDEL=1 -----

Dev	N	Variable	Mean	Std

68.5893578	2	LTIMERR	63.5000000	
.	0	RTIMERR	.	
0.4242641	2	REFA	-1.4000000	

				Dual
				111
0.4949747	2	REFB	0.4500000	
1.3788582	2	REFC	2.1750000	

----- COND=9 TRIAL=3
 STIMDEL=2 -----

Dev	N	Variable	Mean	Std

166.1700936	2	LTIMERR	-91.5000000	
131.5218613	2	RTIMERR	64.0000000	
0.9899495	2	REFA	-3.5000000	
0.2828427	2	REFB	-0.6000000	
3.5001786	2	REFC	-5.2250000	

The SAS System
 09:31 Wednesday, October 30, 1996 166

Procedure		General Linear Models			
		Class Level Information			
		Class	Levels	Values	
7 8 9		SUBJ	9	1 2 3 4 5 6	
		COND	6	1 5 6 7 8 9	
		TRIAL	3	1 2 3	
		STIMDEL	2	1 2	

set = 103
 Number of observations in data

The SAS System

09:31 Wednesday, October 30, 1996 167

General Linear Models

Procedure

Dependent Variable: LTIMERR

Source	DF	Sum of Squares
Mean Square	F Value	Pr > F
Model	102	956216.83495146
9374.67485247	.	.
Error	0	.
.		

Corrected Total	102	956216.83495146
-----------------	-----	-----------------

Root MSE	R-Square	C.V.
	LTIMERR Mean	
	1.000000	0
0	120.28155340	

Source	DF	Type I SS
Mean Square	F Value	Pr > F
COND	5	109738.33866663
21947.66773333	.	.
TRIAL	2	75105.27838460
37552.63919230	.	.
STIMDEL	1	18990.70424888
18990.70424888	.	.
SUBJ(STIMDEL)	7	59530.11739696
8504.30248528	.	.
COND*STIMDEL	5	4798.06410731
959.61282146	.	.
SUBJ*COND(STIMDEL)	32	414750.68571670
12960.95892865	.	.
TRIAL*STIMDEL	2	624.47648989
312.23824495	.	.
COND*TRIAL	10	32148.69711066
3214.86971107	.	.

SUBJ*TRIAL (STIMDEL)	8	41909.13296740
5238.64162092	.	.
COND*TRIAL*STIMDEL	10	64033.06998038
6403.30699804	.	.
SUBJ*COND*TRIA (STIM)	20	134588.26988204
6729.41349410	.	.

Source	DF	Type III SS
Mean Square	F Value	Pr > F
COND	5	116074.45101307
23214.89020261	.	.
TRIAL	2	32778.05761386
16389.02880693	.	.
STIMDEL	1	22994.76413993
22994.76413993	.	.
SUBJ (STIMDEL)	7	54085.17021507
7726.45288787	.	.
COND*STIMDEL	5	17340.41299394
3468.08259879	.	.
SUBJ*COND (STIMDEL)	32	349415.04139217
10919.22004351	.	.
TRIAL*STIMDEL	2	1824.14026477
912.07013238	.	.
COND*TRIAL	10	34554.44586742
3455.44458674	.	.
SUBJ*TRIAL (STIMDEL)	8	44055.09375432
5506.88671929	.	.
COND*TRIAL*STIMDEL	10	64033.06998038
6403.30699804	.	.
SUBJ*COND*TRIA (STIM)	20	134588.26988204
6729.41349410	.	.

Tests of Hypotheses using the Type III MS for
SUBJ*COND (STIMDEL) as an error term

Source	DF	Type III SS
Mean Square	F Value	Pr > F
COND	5	116074.45101307
23214.89020261	2.13	0.0877
COND*STIMDEL	5	17340.41299394
3468.08259879	0.32	0.8987

Tests of Hypotheses using the Type III MS for
SUBJ*TRIAL (STIMDEL) as an error term

Source	Mean Square	DF	F Value	Pr > F	Type III SS
TRIAL		2			32778.05761386
16389.02880693		2.98		0.1081	
TRIAL*STIMDEL		2			1824.14026477
912.07013238		0.17		0.8502	

Tests of Hypotheses using the Type III MS for SUBJ(STIMDEL)
as an error term

Source	Mean Square	DF	F Value	Pr > F	Type III SS
STIMDEL		1			22994.76413993
22994.76413993		2.98		0.1282	

Tests of Hypotheses using the Type III MS for
SUBJ*COND*TRIA(STIM) as an error term

Source	Mean Square	DF	F Value	Pr > F	Type III SS
COND*TRIAL		10			34554.44586742
3455.44458674		0.51		0.8608	
COND*TRIAL*STIMDEL		10			64033.06998038
6403.30699804		0.95		0.5109	

The SAS System

09:31 Wednesday, October 30, 1996 168

General Linear Models

Procedure

Tukey's Studentized Range (HSD) Test for
variable: LTIMERR

NOTE: This test controls the type I
experimentwise error rate.

Alpha= 0.05 Confidence= 0.95 df= 32

MSE= 10919.22

Critical Value of Studentized

Range= 4.284

Dual
115

Comparisons significant at the 0.05 level are indicated by '****'.

Simultaneous		Simultaneous		
Upper Confidence Limit	COND Comparison		Lower	Difference
			Confidence	Between
			Limit	Means
130.86	5	- 6	-80.49	25.19
144.32	5	- 1	-69.79	37.26
174.51	5	- 7	-42.63	65.94
190.86	5	- 8	-26.28	82.29
207.30	5	- 9	-16.97	95.16
80.49	6	- 5	-130.86	-25.19
116.19	6	- 1	-92.03	12.08
146.43	6	- 7	-64.92	40.76
162.78	6	- 8	-48.57	57.11
179.31	6	- 9	-39.35	69.98
69.79	1	- 5	-144.32	-37.26
92.03	1	- 6	-116.19	-12.08
135.73	1	- 7	-78.37	28.68
152.08	1	- 8	-62.02	45.03
168.56	1	- 9	-52.76	57.90
42.63	7	- 5	-174.51	-65.94

				Dual 116
	7	- 6	-146.43	-40.76
64.92	7	- 1	-135.73	-28.68
78.37	7	- 8	-92.22	16.35
124.92	7	- 9	-82.91	29.22
141.35				
	8	- 5	-190.86	-82.29
26.28	8	- 6	-162.78	-57.11
48.57	8	- 1	-152.08	-45.03
62.02	8	- 7	-124.92	-16.35
92.22	8	- 9	-99.26	12.87
125.00				
	9	- 5	-207.30	-95.16
16.97	9	- 6	-179.31	-69.98
39.35	9	- 1	-168.56	-57.90
52.76	9	- 7	-141.35	-29.22
82.91	9	- 8	-125.00	-12.87
99.26				

The SAS System

09:31 Wednesday, October 30, 1996 169

General Linear Models

Procedure

Tukey's Studentized Range (HSD) Test for
variable: LTIMERR

NOTE: This test controls the type I
experimentwise error rate.

Alpha= 0.05 Confidence= 0.95 df= 8
MSE= 5506.887
Range= 4.041
Critical Value of Studentized

Comparisons significant at the 0.05 level are indicated by '***'.

Simultaneous		Simultaneous	
Upper		Lower	Difference
Confidence	TRIAL	Confidence	Between
Limit	Comparison	Limit	Means
92.24	1 - 2	-8.17	42.03
110.51 ***	1 - 3	9.14	59.82
8.17	2 - 1	-92.24	-42.03
72.10	2 - 3	-36.52	17.79
-9.14 ***	3 - 1	-110.51	-59.82
36.52	3 - 2	-72.10	-17.79

The SAS System

09:31 Wednesday, October 30, 1996 170

General Linear Models

Procedure

Tukey's Studentized Range (HSD) Test for
variable: LTIMERR

NOTE: This test controls the type I
experimentwise error rate, but generally
has a higher type II error rate than
REGWQ.

Alpha= 0.05 df= 7 MSE=
7726.453
Critical Value of Studentized
Range= 3.344

Dual
118

Minimum Significant Difference=

41.113

WARNING: Cell sizes are not
equal.

Harmonic Mean of cell sizes=

51.1068

Means with the same letter are not
significantly different.

N	STIMDEL	Tukey Grouping	Mean
47	1	A	132.36
56	2	A	110.14

The SAS System

09:31 Wednesday, October 30, 1996 171

Procedure

General Linear Models

Class Level Information

	Class	Levels	Values
7 8 9	SUBJ	9	1 2 3 4 5 6
	COND	6	1 5 6 7 8 9
	TRIAL	3	1 2 3
	STIMDEL	2	1 2

set = 103

Number of observations in data

The SAS System

09:31 Wednesday, October 30, 1996 172

General Linear Models

Procedure

Dependent Variable: REFA

Source	DF	Sum of Squares
Mean Square	F Value	Pr > F
Model	102	1694.78912621
16.61557967	.	.
Error	0	.
.		
Corrected Total	102	1694.78912621
	R-Square	C.V.
Root MSE	REFA Mean	
	1.000000	0
0	-0.30291262	

Source	DF	Type I SS
Mean Square	F Value	Pr > F
COND	5	30.55321402
6.11064280	.	.
TRIAL	2	0.02089144
0.01044572	.	.
STIMDEL	1	8.64924638
8.64924638	.	.
SUBJ(STIMDEL)	7	230.75725259
32.96532180	.	.
COND*STIMDEL	5	27.59721057
5.51944211	.	.
SUBJ*COND(STIMDEL)	32	598.17407014
18.69293969	.	.
TRIAL*STIMDEL	2	28.72531325
14.36265662	.	.
COND*TRIAL	10	138.46560390
13.84656039	.	.
SUBJ*TRIAL(STIMDEL)	8	111.43433362
13.92929170	.	.
COND*TRIAL*STIMDEL	10	147.31236512
14.73123651	.	.
SUBJ*COND*TRIA(STIM)	20	373.09962519
18.65498126	.	.

Source	Mean Square	DF	F Value	Pr > F	Type III SS
COND	17.26603669	5	.	.	86.33018343
TRIAL	3.31993788	2	.	.	6.63987576
STIMDEL	8.87361338	1	.	.	8.87361338
SUBJ(STIMDEL)	25.09168224	7	.	.	175.64177566
COND*STIMDEL	5.09683063	5	.	.	25.48415315
SUBJ*COND(STIMDEL)	15.45166436	32	.	.	494.45325952
TRIAL*STIMDEL	16.58426899	2	.	.	33.16853797
COND*TRIAL	11.43050264	10	.	.	114.30502644
SUBJ*TRIAL(STIMDEL)	11.93051087	8	.	.	95.44408693
COND*TRIAL*STIMDEL	14.73123651	10	.	.	147.31236512
SUBJ*COND*TRIA(STIM)	18.65498126	20	.	.	373.09962519

Tests of Hypotheses using the Type III MS for
SUBJ*COND(STIMDEL) as an error term

Source	Mean Square	DF	F Value	Pr > F	Type III SS
COND	17.26603669	5	1.12	0.3709	86.33018343
COND*STIMDEL	5.09683063	5	0.33	0.8912	25.48415315

Tests of Hypotheses using the Type III MS for
SUBJ*TRIAL(STIMDEL) as an error term

Source	Mean Square	DF	F Value	Pr > F	Type III SS
TRIAL	3.31993788	2	0.28	0.7641	6.63987576
TRIAL*STIMDEL	16.58426899	2	1.39	0.3033	33.16853797

Tests of Hypotheses using the Type III MS for SUBJ(STIMDEL)
as an error term

Source	DF	Type III SS
Mean Square	F Value	Pr > F
STIMDEL	1	8.87361338
8.87361338	0.35	0.5708

Tests of Hypotheses using the Type III MS for
SUBJ*COND*TRIA(STIM) as an error term

Source	DF	Type III SS
Mean Square	F Value	Pr > F
COND*TRIAL	10	114.30502644
11.43050264	0.61	0.7855
COND*TRIAL*STIMDEL	10	147.31236512
14.73123651	0.79	0.6392

The SAS System

09:31 Wednesday, October 30, 1996 173

General Linear Models

Procedure

Tukey's Studentized Range (HSD) Test for
variable: REFA

NOTE: This test controls the type I
experimentwise error rate.

Alpha= 0.05 Confidence= 0.95 df= 32

MSE= 15.45166

Critical Value of Studentized

Range= 4.284

Comparisons significant at the 0.05 level are
indicated by '***'.

Simultaneous

Simultaneous

Lower Difference

Upper

Confidence Limit	COND		Confidence Limit	Dual 122 Between Means
	Comparison			
	5	- 7	-3.628	0.456
4.540	5	- 9	-3.661	0.557
4.776	5	- 6	-2.839	1.136
5.111	5	- 1	-2.819	1.208
5.235	5	- 8	-2.449	1.635
5.719				
	7	- 5	-4.540	-0.456
3.628	7	- 9	-4.117	0.102
4.320	7	- 6	-3.295	0.680
4.656	7	- 1	-3.275	0.752
4.779	7	- 8	-2.905	1.179
5.264				
	9	- 5	-4.776	-0.557
3.661	9	- 7	-4.320	-0.102
4.117	9	- 6	-3.534	0.579
4.691	9	- 1	-3.512	0.651
4.813	9	- 8	-3.140	1.078
5.296				
	6	- 5	-5.111	-1.136
2.839	6	- 7	-4.656	-0.680
3.295	6	- 9	-4.691	-0.579
3.534	6	- 1	-3.845	0.072
3.988	6	- 8	-3.476	0.499
4.474				

				Dual 123
2.819	1	- 5	-5.235	-1.208
3.275	1	- 7	-4.779	-0.752
3.512	1	- 9	-4.813	-0.651
3.845	1	- 6	-3.988	-0.072
4.454	1	- 8	-3.600	0.427
2.449	8	- 5	-5.719	-1.635
2.905	8	- 7	-5.264	-1.179
3.140	8	- 9	-5.296	-1.078
3.476	8	- 6	-4.474	-0.499
3.600	8	- 1	-4.454	-0.427

The SAS System

09:31 Wednesday, October 30, 1996 174

General Linear Models

Procedure

Tukey's Studentized Range (HSD) Test for
variable: REFA

NOTE: This test controls the type I
experimentwise error rate.

Alpha= 0.05 Confidence= 0.95 df= 8
MSE= 11.93051

Critical Value of Studentized
Range= 4.041

Comparisons significant at the 0.05 level are
indicated by '***'.

Simultaneous	Simultaneous	
Upper	Lower	Difference

Confidence Limit	TRIAL		Confidence Limit	Dual 124 Between Means
	Comparison			
2.37933	1	- 2	-2.29469	0.04232
2.41550	1	- 3	-2.30312	0.05619
2.29469	2	- 1	-2.37933	-0.04232
2.54158	2	- 3	-2.51384	0.01387
2.30312	3	- 1	-2.41550	-0.05619
2.51384	3	- 2	-2.54158	-0.01387

The SAS System

09:31 Wednesday, October 30, 1996 175

General Linear Models

Procedure

Tukey's Studentized Range (HSD) Test for

variable: REFA

NOTE: This test controls the type I

experimentwise error rate.

Alpha= 0.05 Confidence= 0.95 df= 7

MSE= 25.09168

Critical Value of Studentized

Range= 4.165

Comparisons significant at the 0.05 level are

indicated by '***'.

Simultaneous Upper Confidence	TRIAL	Simultaneous	
		Lower Confidence	Difference Between

Limit	Comparison	Limit	Dual 125 Means
	1 - 2	-3.45071	0.04232
3.53535			
	1 - 3	-3.47018	0.05619
3.58256			
	2 - 1	-3.53535	-0.04232
3.45071			
	2 - 3	-3.76420	0.01387
3.79194			
	3 - 1	-3.58256	-0.05619
3.47018			
	3 - 2	-3.79194	-0.01387
3.76420			

09:31 Wednesday, October 30, 1996 176

The SAS System

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Procedure                               General Linear Models
                                         Class Level Information
                                         Class    Levels    Values
7 8 9  SUBJ                            9      1 2 3 4 5 6
                                         COND        6      1 5 6 7 8 9
                                         TRIAL        3      1 2 3
                                         STIMDEL      2      1 2

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set = 103

Number of observations in data

09:31 Wednesday, October 30, 1996 177

The SAS System

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Procedure                               General Linear Models

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Dependent Variable: REFB

Source	Mean Square	DF	F Value	Pr > F	Sum of Squares
Model	6.93723682	102	.	.	707.59815534
Error	.	0	.	.	.
Corrected Total		102			707.59815534
	Root MSE		R-Square	REFB Mean	C.V.
	0		1.000000	-0.93543689	0

Source	Mean Square	DF	F Value	Pr > F	Type I SS
COND	8.85513112	5	.	.	44.27565560
TRIAL	3.53285136	2	.	.	7.06570272
STIMDEL	48.08307590	1	.	.	48.08307590
SUBJ(STIMDEL)	3.23381002	7	.	.	22.63667017
COND*STIMDEL	11.68193112	5	.	.	58.40965561
SUBJ*COND(STIMDEL)	7.41295098	32	.	.	237.21443123
TRIAL*STIMDEL	11.82656986	2	.	.	23.65313971
COND*TRIAL	5.86644286	10	.	.	58.66442864
SUBJ*TRIAL(STIMDEL)	10.06089041	8	.	.	80.48712327
COND*TRIAL*STIMDEL	3.75687698	10	.	.	37.56876978
SUBJ*COND*TRIA(STIM)	4.47697514	20	.	.	89.53950271

Source	Mean Square	DF	F Value	Pr > F	Type III SS
--------	-------------	----	---------	--------	-------------

COND	5		20.48712298
4.09742460	.	.	
TRIAL	2		0.41332964
0.20666482	.	.	
STIMDEL	1		59.88162183
59.88162183	.	.	
SUBJ(STIMDEL)	7		41.47022632
5.92431805	.	.	
COND*STIMDEL	5		29.38685931
5.87737186	.	.	
SUBJ*COND(STIMDEL)	32		216.65410799
6.77044087	.	.	
TRIAL*STIMDEL	2		34.84463300
17.42231650	.	.	
COND*TRIAL	10		58.03976987
5.80397699	.	.	
SUBJ*TRIAL(STIMDEL)	8		44.50909577
5.56363697	.	.	
COND*TRIAL*STIMDEL	10		37.56876978
3.75687698	.	.	
SUBJ*COND*TRIA(STIM)	20		89.53950271
4.47697514	.	.	

Tests of Hypotheses using the Type III MS for
SUBJ*COND(STIMDEL) as an error term

Source	DF		Type III SS
Mean Square	F Value	Pr > F	
COND	5		20.48712298
4.09742460	0.61	0.6964	
COND*STIMDEL	5		29.38685931
5.87737186	0.87	0.5132	

Tests of Hypotheses using the Type III MS for
SUBJ*TRIAL(STIMDEL) as an error term

Source	DF		Type III SS
Mean Square	F Value	Pr > F	
TRIAL	2		0.41332964
0.20666482	0.04	0.9637	
TRIAL*STIMDEL	2		34.84463300
17.42231650	3.13	0.0990	

Tests of Hypotheses using the Type III MS for SUBJ(STIMDEL)
as an error term

Source	DF	Type III SS
Mean Square	F Value	Pr > F
STIMDEL	1	59.88162183
59.88162183	10.11	0.0155

Tests of Hypotheses using the Type III MS for
SUBJ*COND*TRIA(STIM) as an error term

Source	DF	Type III SS
Mean Square	F Value	Pr > F
COND*TRIAL	10	58.03976987
5.80397699	1.30	0.2969
COND*TRIAL*STIMDEL	10	37.56876978
3.75687698	0.84	0.5987

The SAS System

09:31 Wednesday, October 30, 1996 178

General Linear Models

Procedure

Tukey's Studentized Range (HSD) Test for
variable: REFB

NOTE: This test controls the type I
experimentwise error rate.

Alpha= 0.05 Confidence= 0.95 df= 32
MSE= 6.770441
Critical Value of Studentized
Range= 4.284

Comparisons significant at the 0.05 level are
indicated by '***'.

Simultaneous		Simultaneous	
Upper	Lower	Difference	
Confidence	COND	Confidence	Between
Limit	Comparison	Limit	Means

				Dual 129
3.1506	8	- 9	-2.4337	0.3584
3.0524	8	- 1	-2.2789	0.3868
3.3563	8	- 6	-1.9064	0.7249
3.6270	8	- 7	-1.7799	0.9235
4.7711	8	- 5	-0.6358	2.0676
2.4337	9	- 8	-3.1506	-0.3584
2.7839	9	- 1	-2.7272	0.0283
3.0889	9	- 6	-2.3559	0.3665
3.3572	9	- 7	-2.2270	0.5651
4.5014	9	- 5	-1.0829	1.7092
2.2789	1	- 8	-3.0524	-0.3868
2.7272	1	- 9	-2.7839	-0.0283
2.9307	1	- 6	-2.2543	0.3382
3.2024	1	- 7	-2.1289	0.5368
4.3465	1	- 5	-0.9848	1.6809
1.9064	6	- 8	-3.3563	-0.7249
2.3559	6	- 9	-3.0889	-0.3665
2.2543	6	- 1	-2.9307	-0.3382
2.8300	6	- 7	-2.4328	0.1986
3.9741	6	- 5	-1.2886	1.3427
1.7799	7	- 8	-3.6270	-0.9235

				Dual 130
2.2270	7	- 9	-3.3572	-0.5651
2.1289	7	- 1	-3.2024	-0.5368
2.4328	7	- 6	-2.8300	-0.1986
3.8476	7	- 5	-1.5594	1.1441
0.6358	5	- 8	-4.7711	-2.0676
1.0829	5	- 9	-4.5014	-1.7092
0.9848	5	- 1	-4.3465	-1.6809
1.2886	5	- 6	-3.9741	-1.3427
1.5594	5	- 7	-3.8476	-1.1441

The SAS System

09:31 Wednesday, October 30, 1996 179

General Linear Models

Procedure

Tukey's Studentized Range (HSD) Test for

variable: REFB

NOTE: This test controls the type I

experimentwise error rate.

Alpha= 0.05 Confidence= 0.95 df= 8

MSE= 5.563637

Critical Value of Studentized

Range= 4.041

Comparisons significant at the 0.05 level are

indicated by '***'.

		Simultaneous	
Simultaneous		Lower	Difference
Upper			
	TRIAL	Confidence	Between
Confidence			

Limit	Comparison	Limit	Dual 131 Means
2.0861	3 - 1	-1.1361	0.4750
2.3909	3 - 2	-1.0614	0.6648
1.1361	1 - 3	-2.0861	-0.4750
1.7857	1 - 2	-1.4061	0.1898
1.0614	2 - 3	-2.3909	-0.6648
1.4061	2 - 1	-1.7857	-0.1898

The SAS System

09:31 Wednesday, October 30, 1996 180

General Linear Models

Procedure

Tukey's Studentized Range (HSD) Test for
variable: REFB

NOTE: This test controls the type I
experimentwise error rate, but generally
has a higher type II error rate than
REGWQ.

Alpha= 0.05 df= 7 MSE=
5.924318
Critical Value of Studentized
Range= 3.344
Minimum Significant Difference=
1.1384
WARNING: Cell sizes are not
equal.
Harmonic Mean of cell sizes=
51.1068

Means with the same letter are not
significantly different.

		Dual 132	
		Mean	
		Tukey Grouping	
N	STIMDEL		
56	2	A	-0.3491
47	1	B	-1.6340

The SAS System

09:31 Wednesday, October 30, 1996 181

		General Linear Models	
		Class Level Information	
		Class	Levels Values
7	8	SUBJ	9 1 2 3 4 5 6
		COND	6 1 5 6 7 8 9
		TRIAL	3 1 2 3
		STIMDEL	2 1 2

Number of observations in data

set = 103

The SAS System

09:31 Wednesday, October 30, 1996 182

		General Linear Models	
		Procedure	
		Dependent Variable: REFC	
Source	DF	Sum of Squares	
Mean Square	F Value	Pr > F	
Model	102	3457.93873786	
33.90136018	.	.	

Error	0	.
Corrected Total	102	3457.93873786
Root MSE	R-Square	C.V.
0	1.000000	0
	REFC Mean	
	-1.10922330	

Source	Mean Square	DF	F Value	Pr > F	Type I SS
COND	28.95249840	5	.	.	144.76249199
TRIAL	1.69896259	2	.	.	3.39792517
STIMDEL	177.21128043	1	.	.	177.21128043
SUBJ(STIMDEL)	35.29738454	7	.	.	247.08169177
COND*STIMDEL	45.15598411	5	.	.	225.77992057
SUBJ*COND(STIMDEL)	23.70160109	32	.	.	758.45123487
TRIAL*STIMDEL	19.46138820	2	.	.	38.92277640
COND*TRIAL	38.01066642	10	.	.	380.10666418
SUBJ*TRIAL(STIMDEL)	29.89505762	8	.	.	239.16046098
COND*TRIAL*STIMDEL	41.05000223	10	.	.	410.50002234
SUBJ*COND*TRIA(STIM)	41.62821346	20	.	.	832.56426917

Source	Mean Square	DF	F Value	Pr > F	Type III SS
COND	39.91281066	5	.	.	199.56405330
TRIAL	4.15381066	2	.	.	8.30762132
STIMDEL	143.45585666	1	.	.	143.45585666

SUBJ(STIMDEL)	7		225.32668643
32.18952663	.	.	
COND*STIMDEL	5		278.19497778
55.63899556	.	.	
SUBJ*COND(STIMDEL)	32		661.56051491
20.67376609	.	.	
TRIAL*STIMDEL	2		46.50477782
23.25238891	.	.	
COND*TRIAL	10		401.10056169
40.11005617	.	.	
SUBJ*TRIAL(STIMDEL)	8		244.35703765
30.54462971	.	.	
COND*TRIAL*STIMDEL	10		410.50002234
41.05000223	.	.	
SUBJ*COND*TRIA(STIM)	20		832.56426917
41.62821346	.	.	

Tests of Hypotheses using the Type III MS for
SUBJ*COND(STIMDEL) as an error term

Source	DF	Type III SS
Mean Square	F Value	Pr > F
COND	5	199.56405330
39.91281066	1.93	0.1166
COND*STIMDEL	5	278.19497778
55.63899556	2.69	0.0386

Tests of Hypotheses using the Type III MS for
SUBJ*TRIAL(STIMDEL) as an error term

Source	DF	Type III SS
Mean Square	F Value	Pr > F
TRIAL	2	8.30762132
4.15381066	0.14	0.8748
TRIAL*STIMDEL	2	46.50477782
23.25238891	0.76	0.4981

Tests of Hypotheses using the Type III MS for SUBJ(STIMDEL)
as an error term

Source	DF	Type III SS
Mean Square	F Value	Pr > F
STIMDEL	1	143.45585666
143.45585666	4.46	0.0727

Tests of Hypotheses using the Type III MS for
SUBJ*COND*TRIA(STIM) as an error term

Source	DF	Type III SS
Mean Square	F Value	Pr > F
COND*TRIAL	10	401.10056169
40.11005617	0.96	0.5020
COND*TRIAL*STIMDEL	10	410.50002234
41.05000223	0.99	0.4855

The SAS System

09:31 Wednesday, October 30, 1996 183

General Linear Models

Procedure

Tukey's Studentized Range (HSD) Test for
variable: REFC

NOTE: This test controls the type I
experimentwise error rate.

Alpha= 0.05 Confidence= 0.95 df= 32

MSE= 20.67377

Critical Value of Studentized

Range= 4.284

Comparisons significant at the 0.05 level are
indicated by '****'.

Simultaneous		Simultaneous	
Upper		Lower	Difference
Confidence	COND	Confidence	Between
Limit	Comparison	Limit	Means
	7 - 9	-3.348	1.531
6.410	7 - 6	-1.957	2.641
7.240	7 - 1	-1.956	2.702
7.361			

				Dual 136
8.098	7	- 8	-1.351	3.374
8.142	7	- 5	-1.306	3.418
3.348	9	- 7	-6.410	-1.531
5.868	9	- 6	-3.646	1.111
5.987	9	- 1	-3.643	1.172
6.722	9	- 8	-3.036	1.843
6.766	9	- 5	-2.992	1.887
1.957	6	- 7	-7.240	-2.641
3.646	6	- 9	-5.868	-1.111
4.591	6	- 1	-4.469	0.061
5.330	6	- 8	-3.866	0.732
5.374	6	- 5	-3.822	0.776
1.956	1	- 7	-7.361	-2.702
3.643	1	- 9	-5.987	-1.172
4.469	1	- 6	-4.591	-0.061
5.329	1	- 8	-3.987	0.671
5.373	1	- 5	-3.943	0.715
1.351	8	- 7	-8.098	-3.374
3.036	8	- 9	-6.722	-1.843
3.866	8	- 6	-5.330	-0.732
3.987	8	- 1	-5.329	-0.671
4.768	8	- 5	-4.680	0.044

				Dual 137
1.306	5	- 7	-8.142	-3.418
2.992	5	- 9	-6.766	-1.887
3.822	5	- 6	-5.374	-0.776
3.943	5	- 1	-5.373	-0.715
4.680	5	- 8	-4.768	-0.044

The SAS System

09:31 Wednesday, October 30, 1996 184

General Linear Models

Procedure

Tukey's Studentized Range (HSD) Test for
variable: REFC

NOTE: This test controls the type I
experimentwise error rate.

Alpha= 0.05 Confidence= 0.95 df= 8

MSE= 30.54463

Critical Value of Studentized

Range= 4.041

Comparisons significant at the 0.05 level are
indicated by '***'.

Simultaneous		Simultaneous	
Upper		Lower	Difference
Confidence	TRIAL	Confidence	Between
Limit	Comparison	Limit	Means
3.7996	2 - 1	-3.6792	0.0602
4.4847	2 - 3	-3.6043	0.4402

				Dual 138
3.6792	1	- 2	-3.7996	-0.0602
4.1551	1	- 3	-3.3951	0.3800
3.6043	3	- 2	-4.4847	-0.4402
3.3951	3	- 1	-4.1551	-0.3800

The SAS System

09:31 Wednesday, October 30, 1996 185

General Linear Models

Procedure

Tukey's Studentized Range (HSD) Test for
variable: REFC

NOTE: This test controls the type I
experimentwise error rate, but generally
has a higher type II error rate than
REGWQ.

Alpha= 0.05 df= 7 MSE=

32.18953

Critical Value of Studentized

Range= 3.344

Minimum Significant Difference=

2.6537

WARNING: Cell sizes are not
equal.

Harmonic Mean of cell sizes=

51.1068

Means with the same letter are not
significantly different.

N	STIMDEL	Tukey Grouping	Mean
47	1	A	0.270
56	2	A	-2.267

The SAS System

09:31 Wednesday, October 30, 1996 186

General Linear Models

Procedure

Class Level Information

	Class	Levels	Values
7 8 9	SUBJ	9	1 2 3 4 5 6
	COND	6	1 5 6 7 8 9
	TRIAL	3	1 2 3
	STIMDEL	2	1 2

Number of observations in data

set = 103

The SAS System

09:31 Wednesday, October 30, 1996 187

General Linear Models

Procedure

Dependent Variable: LTIMERR

Source	DF	Sum of Squares
Mean Square	F Value	Pr > F
Model	102	956216.83495146
9374.67485247	.	.
Error	0	.
.		
Corrected Total	102	956216.83495146
R-Square		
Root MSE	LTIMERR Mean	C.V.

1.000000 0
0 120.28155340

Source	Mean Square	DF	F Value	Pr > F	Type I SS
COND		5			109738.33866663
21947.66773333	.		.		
TRIAL		2			75105.27838460
37552.63919230	.		.		
STIMDEL		1			18990.70424888
18990.70424888	.		.		
SUBJ (STIMDEL)		7			59530.11739696
8504.30248528	.		.		
COND*STIMDEL		5			4798.06410731
959.61282146	.		.		
SUBJ*COND (STIMDEL)		32			414750.68571670
12960.95892865	.		.		
TRIAL*STIMDEL		2			624.47648989
312.23824495	.		.		
COND*TRIAL		10			32148.69711066
3214.86971107	.		.		
SUBJ*TRIAL (STIMDEL)		8			41909.13296740
5238.64162092	.		.		
COND*TRIAL*STIMDEL		10			64033.06998038
6403.30699804	.		.		
SUBJ*COND*TRIA (STIM)		20			134588.26988204
6729.41349410	.		.		

Source	Mean Square	DF	F Value	Pr > F	Type III SS
COND		5			116074.45101307
23214.89020261	.		.		
TRIAL		2			32778.05761386
16389.02880693	.		.		
STIMDEL		1			22994.76413993
22994.76413993	.		.		
SUBJ (STIMDEL)		7			54085.17021507
7726.45288787	.		.		
COND*STIMDEL		5			17340.41299394
3468.08259879	.		.		
SUBJ*COND (STIMDEL)		32			349415.04139217
10919.22004351	.		.		
TRIAL*STIMDEL		2			1824.14026477
912.07013238	.		.		

COND*TRIAL	10	34554.44586742
3455.44458674	.	.
SUBJ*TRIAL(STIMDEL)	8	44055.09375432
5506.88671929	.	.
COND*TRIAL*STIMDEL	10	64033.06998038
6403.30699804	.	.
SUBJ*COND*TRIA(STIM)	20	134588.26988204
6729.41349410	.	.

The SAS System

09:31 Wednesday, October 30, 1996 188

General Linear Models

Procedure

Dependent Variable: REFA

Source	DF	Sum of Squares
Mean Square	F Value	Pr > F
Model	102	1694.78912621
16.61557967	.	.
Error	0	.
.		
Corrected Total	102	1694.78912621

Root MSE	R-Square	REFA Mean	C.V.
0	1.000000	-0.30291262	0

Source	DF	Type I SS
Mean Square	F Value	Pr > F
COND	5	30.55321402
6.11064280	.	.
TRIAL	2	0.02089144
0.01044572	.	.
STIMDEL	1	8.64924638
8.64924638	.	.
SUBJ(STIMDEL)	7	230.75725259
32.96532180	.	.
COND*STIMDEL	5	27.59721057
5.51944211	.	.

SUBJ*COND (STIMDEL)	32		598.17407014
18.69293969	.	.	
TRIAL*STIMDEL	2		26.72531325
14.36265662	.	.	
COND*TRIAL	10		138.46560390
13.84656039	.	.	
SUBJ*TRIAL (STIMDEL)	8		111.43433362
13.92929170	.	.	
COND*TRIAL*STIMDEL	10		147.31236512
14.73123651	.	.	
SUBJ*COND*TRIA (STIM)	20		373.09962519
18.65498126	.	.	

Source	DF	Type III SS
Mean Square	F Value	Pr > F
COND	5	86.33018343
17.26603669	.	.
TRIAL	2	6.63987576
3.31993788	.	.
STIMDEL	1	8.87361338
8.87361338	.	.
SUBJ (STIMDEL)	7	175.64177566
25.09168224	.	.
COND*STIMDEL	5	25.48415315
5.09683063	.	.
SUBJ*COND (STIMDEL)	32	494.45325952
15.45166436	.	.
TRIAL*STIMDEL	2	33.16853797
16.58426899	.	.
COND*TRIAL	10	114.30502644
11.43050264	.	.
SUBJ*TRIAL (STIMDEL)	8	95.44408693
11.93051087	.	.
COND*TRIAL*STIMDEL	10	147.31236512
14.73123651	.	.
SUBJ*COND*TRIA (STIM)	20	373.09962519
18.65498126	.	.

The SAS System

09:31 Wednesday, October 30, 1996 189

General Linear Models

Procedure

Dependent Variable: REFB

Source	DF	Sum of Squares
Mean Square	F Value	Pr > F

Model	102	707.59815534
6.93723682	.	.
Error	0	.
.		
Corrected Total	102	707.59815534
Root MSE	R-Square	C.V.
	REFB Mean	
	1.000000	0
0	-0.93543689	

Source	DF	Type I SS
Mean Square	F Value	Pr > F
COND	5	44.27565560
8.85513112	.	.
TRIAL	2	7.06570272
3.53285136	.	.
STIMDEL	1	48.08307590
48.08307590	.	.
SUBJ(STIMDEL)	7	22.63667017
3.23381002	.	.
COND*STIMDEL	5	58.40965561
11.68193112	.	.
SUBJ*COND(STIMDEL)	32	237.21443123
7.41295098	.	.
TRIAL*STIMDEL	2	23.65313971
11.82656986	.	.
COND*TRIAL	10	58.66442864
5.86644286	.	.
SUBJ*TRIAL(STIMDEL)	8	80.48712327
10.06089041	.	.
COND*TRIAL*STIMDEL	10	37.56876978
3.75687698	.	.
SUBJ*COND*TRIA(STIM)	20	89.53950271
4.47697514	.	.

Source	DF	Type III SS
Mean Square	F Value	Pr > F
COND	5	20.48712298
4.09742460	.	.

TRIAL	2	0.41332964
0.20666482	.	.
STIMDEL	1	59.88162183
59.88162183	.	.
SUBJ(STIMDEL)	7	41.47022632
5.92431805	.	.
COND*STIMDEL	5	29.38685931
5.87737186	.	.
SUBJ*COND(STIMDEL)	32	216.65410799
6.77044087	.	.
TRIAL*STIMDEL	2	34.84463300
17.42231650	.	.
COND*TRIAL	10	58.03976987
5.80397699	.	.
SUBJ*TRIAL(STIMDEL)	8	44.50909577
5.56363697	.	.
COND*TRIAL*STIMDEL	10	37.56876978
3.75687698	.	.
SUBJ*COND*TRIA(STIM)	20	89.53950271
4.47697514	.	.

The SAS System

09:31 Wednesday, October 30, 1996 190

General Linear Models

Procedure

Dependent Variable: REFC

Source	DF	Sum of Squares
Mean Square	F Value	Pr > F
Model	102	3457.93873786
33.90136018	.	.
Error	0	.
.		

Corrected Total	102	3457.93873786
-----------------	-----	---------------

Root MSE	R-Square	C.V.
	REFC Mean	
0	1.000000	0
	-1.10922330	

Source	DF	Type I SS
Mean Square	F Value	Pr > F

COND	5		144.76249199
28.95249840	.	.	
TRIAL	2		3.39792517
1.69896259	.	.	
STIMDEL	1		177.21128043
177.21128043	.	.	
SUBJ(STIMDEL)	7		247.08169177
35.29738454	.	.	
COND*STIMDEL	5		225.77992057
45.15598411	.	.	
SUBJ*COND(STIMDEL)	32		758.45123487
23.70160109	.	.	
TRIAL*STIMDEL	2		38.92277640
19.46138820	.	.	
COND*TRIAL	10		380.10666418
38.01066642	.	.	
SUBJ*TRIAL(STIMDEL)	8		239.16046098
29.89505762	.	.	
COND*TRIAL*STIMDEL	10		410.50002234
41.05000223	.	.	
SUBJ*COND*TRIA(STIM)	20		832.56426917
41.62821346	.	.	

Source	DF	Type III SS
Mean Square	F Value	Pr > F
COND	5	199.56405330
39.91281066	.	.
TRIAL	2	8.30762132
4.15381066	.	.
STIMDEL	1	143.45585666
143.45585666	.	.
SUBJ(STIMDEL)	7	225.32668643
32.18952663	.	.
COND*STIMDEL	5	278.19497778
55.63899556	.	.
SUBJ*COND(STIMDEL)	32	661.56051491
20.67376609	.	.
TRIAL*STIMDEL	2	46.50477782
23.25238891	.	.
COND*TRIAL	10	401.10056169
40.11005617	.	.
SUBJ*TRIAL(STIMDEL)	8	244.35703765
30.54462971	.	.
COND*TRIAL*STIMDEL	10	410.50002234
41.05000223	.	.

SUBJ*COND*TRIA (STIM) 20
41.62821346 . .

832.56426917

Dual
146

APPENDIX F - SAS Program for Simple Main Effects

```

DATA NEWDATA;
OPTIONS PS=120;
INPUT SUBJ COND TRIAL STIMDEL LTIMERR RTIMERR REFA REFB
REFC@;
OUTPUT;

CARDS;

1      5      1      1      150      .      6.15      -
6.95    8.05
1      5      2      1      129      .      0.25      -
0.40    3.20
1      5      3      1      31       .      -1.35      -
1.95    -9.95
1      6      1      1      93       .      -4.00      -
1.35    -11.85
1      6      2      1      133      .      1.85      -
6.30    9.35
1      7      1      1      87       .      -1.40      -
1.15    -3.80

```

						Dual 148	
1	7	2	1	5	.	-0.70	-
4.40	6.60						
1	7	3	1	13	.	-0.05	1.10
18.40							
1	8	1	1	213	.	-0.85	0.80
3.30							
1	8	2	1	52	.	0.20	-
1.25	-7.10						
1	8	3	1	159	.	-4.15	0.05
0.45							
1	9	1	1	102	.	4.35	-
0.25	-3.75						
1	9	2	1	97	.	0.00	-
0.65	-5.65						
1	9	3	1	112	.	-1.10	0.80
3.15							
1	1	1	1	91	.	3.15	-
0.65	-1.70						
1	1	2	1	128	.	2.80	-
0.40	-3.60						
1	1	3	1	105	.	1.25	-
0.25	-2.55						
2	5	1	2	176	.	1.40	-
2.30	-11.75						

							Dual 149	
2	5	2	2	149	-58	-2.90	-	
0.35	5.50							
2	5	3	2	84	-53	-0.20	-	
1.10	-12.65							
2	6	1	2	39	.	1.10	-	
2.85	-16.05							
2	6	2	2	82	-6	-0.95	0.90	
	-21.45							
2	6	3	2	115	9	-0.90	-	
1.45	-1.10							
2	7	1	2	93	.	-3.15	-	
0.45	-1.60							
2	7	2	2	75	25	2.70	-	
2.30	-5.00							
2	7	3	2	49	-38	-3.90	1.55	
	0.50							
2	8	1	2	60	.	-4.25	0.15	
	-0.75							
2	9	1	2	218	.	7.50	-	
0.45	-0.75							
2	1	1	2	133	.	-10.90	-	
3.15	-0.95							
2	1	2	2	104	.	0.55	-	
1.75	0.65							

							Dual 150
2	1	3	2	149	148	6.05	8.00
	0.55						
3	6	2	1	278	.	7.80	0.25
	4.75						
3	6	3	1	168	.	4.00	-
1.20	-0.30						
3	8	2	1	36	.	0.25	-
1.25	-0.40						
3	8	3	1	-229	.	3.45	-
0.75	-0.40						
3	1	3	1	303	.	5.80	-
0.75	-11.25						
4	5	2	2	173	-55	1.65	0.00
	-6.70						
4	5	3	2	130	-46	1.70	-
0.65	-5.15						
4	6	2	2	236	29	-11.85	-
6.95	-14.45						
4	6	3	2	130	-8	-3.05	-
2.90	2.90						
4	7	2	2	131	-8	5.60	-
0.50	-1.40						
4	7	3	2	186	86	2.00	0.25
	-0.80						

						Dual 151	
4	8	2	2	228	117	-5.50	-
0.30	-3.20						
4	8	3	2	75	-53	-1.90	0.20
	-1.20						
4	9	2	2	-111	-183	8.35	-
0.55	-2.80						
4	9	3	2	26	-29	-2.80	-
0.80	-7.70						
4	1	2	2	40	90	5.70	-
0.35	-3.85						
4	1	3	2	58	51	-3.00	0.95
	-0.20						
5	5	1	1	259	.	2.25	-
1.95	2.15						
5	6	1	1	211	.	0.35	2.95
	16.00						
5	6	2	1	91	.	-0.85	0.25
	-1.75						
5	6	3	1	144	.	1.95	-
0.80	1.65						
5	7	1	1	98	.	2.90	-
3.35	0.70						
5	7	2	1	208	.	-1.65	0.50
	2.05						

							Dual 152	
5	7	3	1	143	.	1.70	-	
1.45	1.25							
5	8	1	1	167	.	1.55	2.65	
0.25								
5	8	2	1	162	.	-0.45	-	
2.25	-1.25							
5	8	3	1	101	.	-4.40	-	
1.05	-5.25							
5	9	1	1	-46	.	1.10	-	
1.75	2.90							
5	9	2	1	50	.	-0.40	-	
3.00	0.95							
5	9	3	1	15	.	-1.70	0.10	
1.20								
5	1	1	1	141	.	-2.65	-	
10.30	-3.15							
6	5	1	2	164	0	-4.10	-	
1.60	-0.70							
6	5	2	2	146	41	-2.65	-	
0.75	-3.60							
6	5	3	2	107	-18	-0.90	-	
0.60	2.60							
6	6	1	2	98	0	-0.05	0.65	
4.75								

							Dual 153
6	6	2	2	133	107	-6.55	1.15
0.00							
6	6	3	2	87	72	0.25	-
0.05	0.00						
6	7	1	2	24	0	-0.55	-
0.05	3.25						
6	7	2	2	-89	-85	-0.65	-
2.00	6.10						
6	7	3	2	67	87	-1.20	-
1.30	2.55						
6	8	1	2	28	.	5.70	-
0.05	-2.70						
6	8	2	2	-6	30	1.45	-
0.05	-3.55						
6	8	3	2	98	100	4.40	-
1.55	-5.25						
6	9	1	2	204	.	-1.65	0.25
1.70							
6	9	2	2	210	255	-4.50	0.15
0.75							
6	9	3	2	-209	157	-4.20	-
0.40	-2.75						
6	1	1	2	159	.	-0.95	-
0.30	-0.30						

							Dual 154	
6	1	2	2	102	127	9.05	-	
0.30	1.35							
6	1	3	2	135	154	-11.15	6.70	
	0.05							
7	5	1	1	352	.	-2.25	-	
4.20	-4.60							
7	5	2	1	211	.	-3.45	-	
4.30	8.30							
7	5	3	1	181	.	3.60	-	
12.85	-10.65							
7	6	1	1	188	.	0.60	-	
1.20	6.85							
7	6	2	1	26	.	-7.80	1.60	
	0.00							
7	7	1	1	279	.	1.90	-	
3.60	-4.25							
7	8	1	1	267	.	-7.05	0.05	
	-6.75							
7	9	1	1	270	.	-4.30	-	
1.60	8.60							
7	1	1	1	115	.	-2.75	1.60	
	-4.00							
7	1	2	1	149	.	-7.15	-	
1.85	6.55							

							Dual 155	
7	1	3	1	183	.	-0.10	-	
4.10	0.00							
8	5	1	2	179	.	7.30	0.60	
	-3.70							
8	6	1	2	292	.	0.80	-	
1.10	-0.40							
8	7	1	2	114	.	-0.10	-	
0.95	-2.25							
8	8	1	2	131	.	-3.35	1.90	
	-0.65							
8	9	1	2	80	.	-1.30	-	
1.25	0.00							
8	1	1	2	133	.	-8.05	2.35	
	0.85							
9	5	1	2	265	.	2.75	1.00	
	1.85							
9	6	1	2	203	.	6.05	1.05	
	-6.40							
9	7	1	2	282	.	-1.95	-	
0.80	-2.00							
9	8	1	2	-55	.	-3.65	-	
0.50	-2.60							
9	9	1	2	101	.	0.45	1.20	
	-0.90							

							Dual 156	
9	1	1	2	157	.	0.40	-	
5.80	-5.60							

```
PROC SORT; BY STIMDEL COND;
```

```
RUN;
```

```
PROC MEANS MEAN STDERR USS CSS; BY STIMDEL COND;
```

```
RUN;
```

```
* Sorts by STIMDEL, collapses COND across STIMDEL;
```

```
* Tukey test COND@STIMDEL1 COND@STIMDEL2;
```

```
PROC SORT; BY STIMDEL;
```

```
RUN;
```

```
PROC glm; BY STIMDEL; CLASS COND subj; MODEL refc = COND  
subj*cond;
```

```
test h=cond e=subj*cond;
```

```
MEANS COND / TUKEY;
```

```
RUN;
```

```
* Sorts by B, collapses STIMDEL across COND;
```

```
* Tukey test STIMDEL@COND1 STIMDEL@COND2 STIMDEL2COND3 etc;
```

```
PROC SORT; BY COND;
```

```
RUN;
```

```
PROC glm; BY COND; CLASS STIMDEL; MODEL refc = STIMDEL;
```

```
MEANS STIMDEL / TUKEY;
```

```
RUN;
```

```
--
```


APPENDIX G - SAS Output for Simple Main Effects

SAS 22:37 Monday, September 5, 1994 27

----- STIMDEL=1 COND=1 -----

N Obs	Variable	USS	Mean	CSS
Std Error				
8	SUBJ	184.0000000	4.0000000	56.0000000
1.0000000				
	TRIAL	38.0000000	2.0000000	6.0000000
0.3273268				
	LTIMERR	216295.00	151.8750000	31766.88
23.8173387				
	RTIMERR	.	.	.
	REFA	118.6825000	0.0437500	118.6671875
1.4556981				
	REFB	130.0900000	-2.0875000	95.2287500
1.3040373				
	REFC	217.7400000	-2.4625000	169.2287500
1.7383734				

----- STIMDEL=1 COND=5 -----

N Obs	Variable	USS	Mean	CSS
Std Error				
7	SUBJ	175.0000000	4.1428571	54.8571429
1.1428571				
	TRIAL	29.0000000	1.8571429	4.8571429
0.3400680				
	LTIMERR	308369.00	187.5714286	62087.71
38.4483928				

				Dual 159
	RTIMERR	.	.	.
	REFA	74.6950000	0.7428571	70.8321429
1.2986453	REFB	257.3200000	-4.6571429	105.4971429
1.5848775	REFC	382.1400000	-0.5000000	380.3900000
3.0094692				

----- STIMDEL=1 COND=6 -----

N Obs	Variable	USS	Mean	CSS
Std Error				

9	SUBJ	193.0000000	4.1111111	40.8888889
0.7535922				
	TRIAL	37.0000000	1.8888889	4.8888889
0.2605787				
	LTIMERR	241404.00	148.0000000	44268.00
24.7958330				
	RTIMERR	.	.	.
	REFA	162.1100000	0.4333333	160.4200000
1.4926673				
	REFB	56.4200000	-0.6444444	52.6822222
0.8553932				
	REFC	559.2050000	2.7444444	491.4172222
2.6125159				

----- STIMDEL=1 COND=7 -----

N Obs	Variable	USS	Mean	CSS
Std Error				

7	SUBJ	127.0000000	3.5714286	37.7142857
0.9476071				
	TRIAL	29.0000000	1.8571429	4.8571429
0.3400680				

				Dual 160
LTIMERR	158921.00	119.0000000		59794.00
37.7315076				
RTIMERR	.	.		.
.				
REFA	20.0850000	0.3857143		19.0435714
0.6733635				
REFB	48.4275000	-1.7642857		26.6385714
0.7963992				
REFC	420.8775000	2.9928571		358.1771429
2.9202786				

 ----- STIMDEL=1 COND=8 -----

N Obs	Variable	USS	Mean	CSS
Std Error				
9	SUBJ	145.0000000	3.4444444	38.2222222
0.7286043				
	TRIAL	42.0000000	2.0000000	6.0000000
0.2886751				
	LTIMERR	262714.00	103.1111111	167026.89
48.1644880				
	RTIMERR	.	.	.
.				
	REFA	101.6175000	-1.2722222	87.0505556
1.0995615				
	REFB	17.5200000	-0.3333333	16.5200000
0.4790036				
	REFC	136.5725000	-1.9055556	103.8922222
1.2012275				

 ----- STIMDEL=1 COND=9 -----

N Obs	Variable	USS	Mean	CSS
Std Error				
7	SUBJ	127.0000000	3.5714286	37.7142857
0.9476071				

				Dual 161
0.3400680	TRIAL	29.0000000	1.8571429	4.8571429
37.3750071	LTIMERR	110098.00	85.7142857	58669.43
	RTIMERR	.	.	.
1.0033532	REFA	42.8825000	-0.2928571	42.2821429
0.4878803	REFB	15.7575000	-0.9071429	9.9971429
1.7781554	REFC	140.6200000	1.0571429	132.7971429

----- STIMDEL=2 COND=1 -----

N Obs	Variable	USS	Mean	CSS
Std Error				
10	SUBJ	297.0000000	4.9000000	56.9000000
0.7951240				
0.2768875	TRIAL	43.0000000	1.9000000	6.9000000
12.9219882	LTIMERR	151918.00	117.0000000	15028.00
19.3261481	RTIMERR	72450.00	114.0000000	7470.00
2.2463946	REFA	469.2950000	-1.2300000	454.1660000
1.3258551	REFB	162.2425000	0.6350000	158.2102500
0.7066136	REFC	50.4875000	-0.7450000	44.9372500

----- STIMDEL=2 COND=5 -----

N Obs	Variable	USS	Mean	CSS
Std Error				

				Dual 162
10	SUBJ	297.0000000	4.9000000	56.9000000
0.7951240				
	TRIAL	43.0000000	1.9000000	6.9000000
0.2768875				
	LTIMERR	268989.00	157.3000000	21556.10
15.4761824				
	RTIMERR	13319.00	-27.0000000	8216.00
13.9863879				
	REFA	101.5175000	0.4050000	99.8772500
1.0534454				
	REFB	11.8875000	-0.5750000	8.5812500
0.3087835				
	REFC	437.0700000	-3.4300000	319.4210000
1.8839114				

September 5, 1994 28

SAS 22:37 Monday,
Dual
163

----- STIMDEL=2 COND=6 -----

N Obs	Variable	USS	Mean	CSS
Std Error				
10	SUBJ	297.0000000	4.9000000	56.9000000
0.7951240				
	TRIAL	43.0000000	1.9000000	6.9000000
0.2768875				
	LTIMERR	255401.00	141.5000000	55178.50
24.7607440				
	RTIMERR	17655.00	29.0000000	11768.00
16.7388911				
	REFA	232.8575000	-1.5150000	209.9052500
1.5271806				
	REFB	71.8075000	-1.1550000	58.4672500
0.8060001				
	REFC	999.81	-5.2200000	727.3260000
2.8427803				

----- STIMDEL=2 COND=7 -----

N Obs	Variable	USS	Mean	CSS
Std Error				
10	SUBJ	297.0000000	4.9000000	56.9000000
0.7951240				
	TRIAL	43.0000000	1.9000000	6.9000000
0.2768875				
	LTIMERR	173938.00	93.2000000	87075.60
31.1047692				
	RTIMERR	24323.00	9.5714286	23681.71
23.7455331				
	REFA	73.7600000	-0.1200000	73.6160000
0.9044090				
	REFB	15.4425000	-0.6550000	11.1522500
0.3520140				

			Dual
			164
REFC	93.7475000	-0.0650000	93.7052500
1.0203771			

----- STIMDEL=2 COND=8 -----

N Obs	Variable	USS	Mean	CSS
Std Error				

8	SUBJ	289.0000000	5.6250000	35.8750000
0.8003905				
	TRIAL	30.0000000	1.7500000	5.5000000
0.3133916				
	LTIMERR	91819.00	69.8750000	52758.87
30.6940184				
	RTIMERR	27398.00	48.5000000	17989.00
38.7179975				
	REFA	130.4200000	-0.8875000	124.1187500
1.4887600				
	REFB	6.4200000	-0.0250000	6.4150000
0.3384576				
	REFC	66.8800000	-2.4875000	17.3787500
0.5570770				

----- STIMDEL=2 COND=9 -----

N Obs	Variable	USS	Mean	CSS
Std Error				

8	SUBJ	289.0000000	5.6250000	35.8750000
0.8003905				
	TRIAL	30.0000000	1.7500000	5.5000000
0.3133916				
	LTIMERR	206519.00	64.8750000	172848.88
55.5570612				
	RTIMERR	124004.00	50.0000000	114004.00
97.4696534				
	REFA	176.3175000	0.2312500	175.8896875
1.7722549				

			Dual
			165
REFB	4.3925000	-0.2312500	3.9646875
0.2660789			
REFC	79.5175000	-1.5562500	60.1421875
1.0363241			

SAS 22:37 Monday,

September 5, 1994 29

----- STIMDEL=1 -----

General Linear Models Procedure
Class Level Information

Class	Levels	Values
COND	6	1 5 6 7 8 9
SUBJ	4	1 3 5 7

Number of observations in by group = 47

SAS 22:37 Monday,

September 5, 1994 30

----- STIMDEL=1 -----

General Linear Models Procedure

Dependent Variable: REFC

Source		DF	Sum of Squares	Mean Square
F Value	Pr > F			
Model		20	629.1407979	31.4570399
0.67	0.8211			
Error		26	1224.5825000	47.0993269
Corrected Total		46	1853.7232979	
		R-Square	C.V.	Root MSE
		REFC Mean		
		0.339393	2539.812	6.862895
		0.27021277		

Source		DF	Type I SS	Mean Square
F Value	Pr > F			
COND		5	217.8208177	43.5641635
0.92	0.4808			
COND*SUBJ		15	411.3199802	27.4213320
0.58	0.8622			

Source		DF	Type III SS	Mean Square
F Value	Pr > F			
COND		5	249.4866072	49.8973214
1.06	0.4051			
COND*SUBJ		15	411.3199802	27.4213320
0.58	0.8622			

Tests of Hypotheses using the Type III MS for COND*SUBJ as
an error term

Source		DF	Type III SS	Mean Square
F Value	Pr > F			

				Dual 168
COND		5	249.4866072	49.8973214
1.82	0.1694			

SAS 22:37 Monday,

September 5, 1994 31

----- STIMDEL=1 -----

General Linear Models Procedure

Tukey's Studentized Range (HSD) Test for
variable: REFCNOTE: This test controls the type I experimentwise
error rate.Alpha= 0.05 Confidence= 0.95 df= 26 MSE=
47.09933

Critical Value of Studentized Range= 4.345

Comparisons significant at the 0.05 level are
indicated by '****'.

Simultaneous		Simultaneous			
Confidence	COND		Lower Confidence	Difference Between	Upper
	Comparison		Limit	Means	Limit
	7	- 6	-10.378	0.248	10.875
	7	- 9	-9.335	1.936	13.207
	7	- 5	-7.778	3.493	14.764
	7	- 8	-5.728	4.898	15.525
	7	- 1	-5.458	5.455	16.368
	6	- 7	-10.875	-0.248	10.378
	6	- 9	-8.939	1.687	12.314
	6	- 5	-7.382	3.244	13.871
	6	- 8	-5.290	4.650	14.590
	6	- 1	-5.039	5.207	15.453
	9	- 7	-13.207	-1.936	9.335
	9	- 6	-12.314	-1.687	8.939
	9	- 5	-9.714	1.557	12.828
	9	- 8	-7.664	2.963	13.589
	9	- 1	-7.393	3.520	14.433
	5	- 7	-14.764	-3.493	7.778
	5	- 6	-13.871	-3.244	7.382

				Dual
				170
5	- 9	-12.828	-1.557	9.714
5	- 8	-9.221	1.406	12.032
5	- 1	-8.951	1.963	12.876
8	- 7	-15.525	-4.898	5.728
8	- 6	-14.590	-4.650	5.290
8	- 9	-13.589	-2.963	7.664
8	- 5	-12.032	-1.406	9.221
8	- 1	-9.689	0.557	10.803
1	- 7	-16.368	-5.455	5.458
1	- 6	-15.453	-5.207	5.039
1	- 9	-14.433	-3.520	7.393
1	- 5	-12.876	-1.963	8.951
1	- 8	-10.803	-0.557	9.689

Dual
171

SAS 22:37 Monday,

September 5, 1994 32

----- STIMDEL=2 -----

General Linear Models Procedure
Class Level Information

Class	Levels	Values
COND	6	1 5 6 7 8 9
SUBJ	5	2 4 6 8 9

Number of observations in by group = 56

September 5, 1994 33

----- STIMDEL=2 -----

General Linear Models Procedure

Dependent Variable: REFC

Source	Pr > F	DF	Sum of Squares	Mean Square
F Value				
Model		29	761.3943006	26.2549759
1.01	0.4962			
Error		26	678.3270833	26.0895032
Corrected Total		55	1439.7213839	

	R-Square	C.V.	Root MSE
REFC Mean			
	0.528848	-225.3140	5.107788
-2.2669643			

Source	Pr > F	DF	Type I SS	Mean Square
F Value				
COND		5	176.8109464	35.3621893
1.36	0.2731			
COND*SUBJ		24	584.5833542	24.3576398
0.93	0.5653			

Source	Pr > F	DF	Type III SS	Mean Square
F Value				
COND		5	85.8779869	17.1755974
0.66	0.6580			
COND*SUBJ		24	584.5833542	24.3576398
0.93	0.5653			

Tests of Hypotheses using the Type III MS for COND*SUBJ as an error term

Source	Pr > F	DF	Type III SS	Mean Square
F Value				

				Dual
				173
COND		5	85.87798686	17.17559737
0.71	0.6252			

SAS 22:37 Monday,

September 5, 1994 34

----- STIMDEL=2 -----

General Linear Models Procedure

Tukey's Studentized Range (HSD) Test for
variable: REFCNOTE: This test controls the type I experimentwise
error rate.Alpha= 0.05 Confidence= 0.95 df= 26 MSE=
26.0895

Critical Value of Studentized Range= 4.345

Comparisons significant at the 0.05 level are
indicated by '****'.

		Simultaneous		
Simultaneous				
Confidence	COND	Lower Confidence	Difference Between	Upper
	Comparison	Limit	Means	Limit
	7 - 1	-6.338	0.680	7.698
	7 - 9	-5.953	1.491	8.935
	7 - 8	-5.022	2.423	9.867
	7 - 5	-3.653	3.365	10.383
	7 - 6	-1.863	5.155	12.173
	1 - 7	-7.698	-0.680	6.338
	1 - 9	-6.633	0.811	8.255
	1 - 8	-5.702	1.742	9.187
	1 - 5	-4.333	2.685	9.703
	1 - 6	-2.543	4.475	11.493
	9 - 7	-8.935	-1.491	5.953
	9 - 1	-8.255	-0.811	6.633
	9 - 8	-6.916	0.931	8.778
	9 - 5	-5.570	1.874	9.318
	9 - 6	-3.780	3.664	11.108
	8 - 7	-9.867	-2.423	5.022
	8 - 1	-9.187	-1.742	5.702

				Dual
				175
8	- 9	-8.778	-0.931	6.916
8	- 5	-6.502	0.942	8.387
8	- 6	-4.712	2.733	10.177
5	- 7	-10.383	-3.365	3.653
5	- 1	-9.703	-2.685	4.333
5	- 9	-9.318	-1.874	5.570
5	- 8	-8.387	-0.942	6.502
5	- 6	-5.228	1.790	8.808
6	- 7	-12.173	-5.155	1.863
6	- 1	-11.493	-4.475	2.543
6	- 9	-11.108	-3.664	3.780
6	- 8	-10.177	-2.733	4.712
6	- 5	-8.808	-1.790	5.228

SAS 22:37 Monday,

September 5, 1994 35

----- COND=1 -----

General Linear Models Procedure
Class Level Information

Class	Levels	Values
STIMDEL	2	1 2

Number of observations in by group = 18

September 5, 1994 36

SAS 22:37 Monday,
Dual
177

----- COND=1 -----

General Linear Models Procedure

Dependent Variable: REFC

Source		DF	Sum of Squares	Mean Square
F Value	Pr > F			
Model		1	13.11025000	13.11025000
0.98	0.3371			
Error		16	214.16600000	13.38537500
Corrected Total		17	227.27625000	

R-Square	C.V.	Root MSE
REFC Mean		
0.057684	-242.5593	3.658603
-1.5083333		

Source		DF	Type I SS	Mean Square
F Value	Pr > F			
STIMDEL		1	13.11025000	13.11025000
0.98	0.3371			

Source		DF	Type III SS	Mean Square
F Value	Pr > F			
STIMDEL		1	13.11025000	13.11025000
0.98	0.3371			

SAS 22:37 Monday,

September 5, 1994 37

----- COND=1 -----

General Linear Models Procedure

Tukey's Studentized Range (HSD) Test for
variable: REFC

NOTE: This test controls the type I experimentwise
error rate, but
generally has a higher type II error rate
than REGWQ.

Alpha= 0.05 df= 16 MSE= 13.38538
Critical Value of Studentized Range= 2.998
Minimum Significant Difference= 3.6791
WARNING: Cell sizes are not equal.
Harmonic Mean of cell sizes= 8.888889

Means with the same letter are not significantly
different.

	Tukey Grouping	Mean	N	
STIMDEL	A	-0.745	10	2
	A			
	A	-2.463	8	1

SAS 22:37 Monday,

September 5, 1994 38

----- COND=5 -----

General Linear Models Procedure
Class Level Information

Class	Levels	Values
STIMDEL	2	1 2

Number of observations in by group = 17

SAS 22:37 Monday,

September 5, 1994 39

----- COND=5 -----

General Linear Models Procedure

Dependent Variable: REFC

Source		DF	Sum of Squares	Mean Square
F Value	Pr > F			
Model		1	35.34958824	35.34958824
0.76	0.3978			
Error		15	699.81100000	46.65406667
Corrected Total		16	735.16058824	

	R-Square	C.V.	Root MSE
REFC Mean			
	0.048084	-307.1863	6.830378
-2.2235294			

Source		DF	Type I SS	Mean Square
F Value	Pr > F			
STIMDEL		1	35.34958824	35.34958824
0.76	0.3978			

Source		DF	Type III SS	Mean Square
F Value	Pr > F			
STIMDEL		1	35.34958824	35.34958824
0.76	0.3978			

SAS 22:37 Monday,

September 5, 1994 40

----- COND=5 -----

General Linear Models Procedure

Tukey's Studentized Range (HSD) Test for
variable: REFC

NOTE: This test controls the type I experimentwise
error rate, but
generally has a higher type II error rate
than REGWQ.

Alpha= 0.05 df= 15 MSE= 46.65407
Critical Value of Studentized Range= 3.014
Minimum Significant Difference= 7.1747
WARNING: Cell sizes are not equal.
Harmonic Mean of cell sizes= 8.235294

Means with the same letter are not significantly
different.

	Tukey Grouping	Mean	N
STIMDEL			
	A	-0.500	7 1
	A		
	A	-3.430	10 2

SAS 22:37 Monday,

September 5, 1994 41

----- COND=6 -----

General Linear Models Procedure
Class Level Information

Class	Levels	Values
STIMDEL	2	1 2

Number of observations in by group = 19

SAS 22:37 Monday,

September 5, 1994 42

----- COND=6 -----

General Linear Models Procedure

Dependent Variable: REFC

Source	Pr > F	DF	Sum of Squares	Mean Square
F Value				
Model		1	300.4691462	300.4691462
4.19	0.0496			
Error		17	1218.743222	71.6907778
Corrected Total		18	1519.2123684	

	R-Square	C.V.	Root MSE
REFC Mean			
	0.197780	-584.9955	8.467041
-1.4473684			

Source	Pr > F	DF	Type I SS	Mean Square
F Value				
STIMDEL		1	300.4691462	300.4691462
4.19	0.0496			

Source	Pr > F	DF	Type III SS	Mean Square
F Value				
STIMDEL		1	300.4691462	300.4691462
4.19	0.0496			

SAS 22:37 Monday,

September 5, 1994 43

----- COND=6 -----

General Linear Models Procedure

Tukey's Studentized Range (HSD) Test for
variable: REFC

NOTE: This test controls the type I experimentwise
error rate, but
generally has a higher type II error rate
than REGWQ.

Alpha= 0.05 df= 17 MSE= 71.69078
Critical Value of Studentized Range= 2.984
Minimum Significant Difference= 8.2079
WARNING: Cell sizes are not equal.
Harmonic Mean of cell sizes= 9.473684

Means with the same letter are not significantly
different.

	Tukey Grouping	Mean	N
STIMDEL			
	A	2.744	9 1
	A		
	A	-5.220	10 2

SAS 22:37 Monday,

September 5, 1994 44

----- COND=7 -----

General Linear Models Procedure
Class Level Information

Class	Levels	Values
STIMDEL	2	1 2

Number of observations in by group = 17

September 5, 1994 45

SAS 22:37 Monday,
Dual
186

----- COND=7 -----

General Linear Models Procedure

Dependent Variable: REFC

Source		DF	Sum of Squares	Mean Square
F Value	Pr > F			
Model		1	38.50201891	38.50201891
1.28	0.2760			
Error		15	451.88239286	30.12549286
Corrected Total		16	490.38441176	

R-Square	C.V.	Root MSE
REFC Mean		
0.078514	459.6423	5.488669
1.19411765		

Source		DF	Type I SS	Mean Square
F Value	Pr > F			
STIMDEL		1	38.50201891	38.50201891
1.28	0.2760			

Source		DF	Type III SS	Mean Square
F Value	Pr > F			
STIMDEL		1	38.50201891	38.50201891
1.28	0.2760			

SAS 22:37 Monday,

September 5, 1994 46

----- COND=7 -----

General Linear Models Procedure

Tukey's Studentized Range (HSD) Test for
variable: REFC

NOTE: This test controls the type I experimentwise
error rate, but
generally has a higher type II error rate
than REGWQ.

Alpha= 0.05 df= 15 MSE= 30.12549
Critical Value of Studentized Range= 3.014
Minimum Significant Difference= 5.7653
WARNING: Cell sizes are not equal.
Harmonic Mean of cell sizes= 8.235294

Means with the same letter are not significantly
different.

	Tukey Grouping	Mean	N
STIMDEL			
	A	2.993	7 1
	A		
	A	-0.065	10 2

Dual
188

SAS 22:37 Monday,

September 5, 1994 47

----- COND=8 -----

General Linear Models Procedure
Class Level Information

Class	Levels	Values
STIMDEL	2	1 2

Number of observations in by group = 17

September 5, 1994 48

----- COND=8 -----

General Linear Models Procedure

Dependent Variable: REFC

Source		DF	Sum of Squares	Mean Square
F Value	Pr > F			
Model		1	1.43432190	1.43432190
0.18	0.6796			
Error		15	121.27097222	8.08473148
Corrected Total		16	122.70529412	

R-Square	C.V.	Root MSE
REFC Mean		
0.011689	-130.4648	2.843366
-2.1794118		

Source		DF	Type I SS	Mean Square
F Value	Pr > F			
STIMDEL		1	1.43432190	1.43432190
0.18	0.6796			

Source		DF	Type III SS	Mean Square
F Value	Pr > F			
STIMDEL		1	1.43432190	1.43432190
0.18	0.6796			

SAS 22:37 Monday,

September 5, 1994 49

----- COND=8 -----

General Linear Models Procedure

Tukey's Studentized Range (HSD) Test for
variable: REFC

NOTE: This test controls the type I experimentwise
error rate, but generally has a higher type II error rate
than REGWQ.

Alpha= 0.05 df= 15 MSE= 8.084731
Critical Value of Studentized Range= 3.014
Minimum Significant Difference= 2.9449
WARNING: Cell sizes are not equal.
Harmonic Mean of cell sizes= 8.470588

Means with the same letter are not significantly
different.

Tukey Grouping		Mean	N	
STIMDEL				
	A	-1.906	9	1
	A			
	A	-2.487	8	2

Dual
191
SAS 22:37 Monday,
September 5, 1994 50

----- COND=9 -----

General Linear Models Procedure
Class Level Information

Class	Levels	Values
STIMDEL	2	1 2

Number of observations in by group = 15

SAS 22:37 Monday,

September 5, 1994 52

----- COND=9 -----

General Linear Models Procedure

Tukey's Studentized Range (HSD) Test for
variable: REFC

NOTE: This test controls the type I experimentwise
error rate, but
generally has a higher type II error rate
than REGWQ.

Alpha= 0.05 df= 13 MSE= 14.84149
Critical Value of Studentized Range= 3.055
Minimum Significant Difference= 4.3074
WARNING: Cell sizes are not equal.
Harmonic Mean of cell sizes= 7.466667

Means with the same letter are not significantly
different.

	Tukey Grouping	Mean	N
STIMDEL			
	A	1.057	7 1
	A		
	A	-1.556	8 2

--

APPENDIX H - Graphs of means

LTE

REFA

REFB

REFC

LTE

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