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Factors Influencing the Development and Evolution of Remembering Interactions

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by

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Abstract

This dissertation examines the concept of memory from the perspective of a natural science of behavior. In making this analysis, the philosophy of Interbehaviorism and system of Interbehavioral Psychology are described. Further, perspectives on memorial interactions in psychology in general, and behavior analysis in particular are examined. A number of implications and limitations of these perspectives are exposed. An alternative conceptualization of memory, derived from a natural science of behavior, is described, along with a comprehensive review of memorial interactions. Included in this review are memorial interactions of the remembering, reminiscing, and memorizing types. The aim of this analysis is to provide a naturalistic approach to memorial interactions of various sorts, such that future work may be pursued from this foundation. An experimental analysis of remembering interactions is explored, and results are reviewed. The implications of the data are considered and future conceptual and experimental work is suggested. Such studies are of importance within the analysis of behavior, as they expand the scope of events available for investigation, and facilitate an understanding of complex psychological happenings within a thoroughly naturalistic framework.

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CHAPTER 1

Introduction

Philosophical Foundation

All of our behavior seems to be impacted by our historical experiences, and few would argue with this fundamental observation. It is interesting then, that psychological science seems to have made little progress in the important area of memory. That is to say, while memory is of obvious importance to all participating in the field of psychology, there is little scientific merit to, or agreement within any particular approach to understanding memorial interactions. Indeed, there are few, if any, scientific articulations of how our historical experiences influence our day to day interactions. Thus, while the past has considerable significance in behavior science, there is currently no coherent, scientific conceptualization of the past.

The observation that behavior science has made little progress in the area of memory is not based on an independent examination of reality, nor is it to be seen as more or less objective than other perspectives (Hayes, 1993, 1997a, 1997b). In other words, such a critique is unique to the observer making the critique. All scientific work is conducted by observers who cannot possibly separate themselves from the act of observation, scientific or otherwise. Thus, scientific work cannot be evaluated based on the extent to which it provides a more or less valid understanding of reality, as reality itself is a subjective construct, determined by one’s orientation to the world more generally. More specifically, scientific work is always influenced by the philosophical assumptions of its workers, regardless of whether or not they are aware of this influence (Hayes & Thomas, 2004; Kantor, 1953, p. 28). In any event, awareness of this circumstance does not reduce the overwhelming influence philosophy has on scientific practices. Rather, such awareness highlights the importance of fully articulating and examining one's own philosophy with respect to events (see Kantor, 1959; Kantor & Smith, 1975). For this reason it has been said that such a pursuit is the goal of all systemization in science (Clayton, Hayes, & Swain, 2005; Kantor, 1959).

Obviously then, my own work cannot be conducted in the absence of my unique experiences with the world and the assumptions I have with respect to it. My work as scientists is determined by the philosophical assumptions I have with respect to the events under investigation. Given this perspective, it is important to articulate my general assumptions regarding the scientific domain and the science of behavior in particular. Before doing so, I must acknowledge the primary source of these assumptions. They are based on J.R. Kantor's philosophy of Interbehaviorism (e.g., Kantor, 1953, 1969), his system of Interbehavioral Psychology (Kantor, 1924, 1926, 1942, 1959, 1982), as well as unique extensions derived from this philosophy (e.g., Hayes, 1992b, 1993, 1997a, 1997b, 1998; Parrott, 1983a, 1983b, 1983c, 1986). As these assumptions are relatively unconventional within the behavior analytic community, they are now described briefly below.

From an interbehavioral perspective the natural world is viewed as an integrated field of factors, all of which participate in the unfolding of events. This is to say, the world is a multi-factored field (Kantor, 1959; Smith, 2006), with all of its factors being *inter*dependent, comprising *one* integrated whole. Of course, the whole cannot actually be confronted and studied[1]. Accordingly, individual sciences identify particular aspects of the whole for their special study, these becoming the subject matters of the individual

[1] See Hayes, 1993, 1997a, 1997b for related discussions.

scientific enterprises. Importantly, this perspective prevents hypothetical entities from entering the scientific domain. Hypothetical entities are, by definition, non-existent, and thus, cannot be identified in the spatiotemporal event matrix that is the natural world (Fryling & Hayes, 2009; Kantor, 1957; Smith, 2007). Given this, all historical and current scientific philosophies in which hypothetical entities are implicated are dismissed as lacking scientific merit. Events that cannot be confronted cannot be investigated whereby nothing can be learned about them. Enterprises that implicate non-events in their systems cannot be considered scientific in nature.

There are other important features related to the subject matter selection. First, it must be acknowledged that the identification of the subject matter of individual sciences is an arbitrary procedure. This means that "psychological" events do not exist in the natural world. Instead a particular type of event is isolated and *called* "psychological". While subject matter isolation is indeed an arbitrary procedure, this does not imply that a discipline's focus on a particular type of event may be altered for particular purposes. The progress of individual scientific enterprises depends upon their continued study of the same sets of events because overlooking their subject matter boundary conditions undermines the cumulative nature of scientific progress. Put differently, the progress of an individual science depends on its identification of a distinct subject matter, such that all work can relate to, and build upon the work of others in the enterprise.[2]

Of course, all sciences find themselves related to one another, some more so than others (Observer, 1968). The science of psychology finds itself closely related to the sciences of biology and sociology, for example. This is not surprising, as all sciences are derived from the same natural world, the same multi-factor field of natural events

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[2] See Hayes & Fryling, in press, for an extended discussion of these issues.

(Kantor, 1953). However, the value of individual sciences depends upon their identification and isolation of a *unique* aspect of the natural world, such that they are contributing to the more general understanding of its happenings. For this reason, individual sciences must pay close attention to the boundary conditions between the various scientific enterprises. While psychology may be closely related to biology and sociology, it's progress cannot be assured if it's subject matter is confused or blended together with those of these other sciences. When boundary conditions are not clearly drawn, or overlooked, one science often gets overshadowed by the other. Most often, the science assumed to be foundational to the other overshadows the science assumed to have its basis within it. For example, psychological events have been assumed to be based upon biological events, biological events based upon chemical events, chemical events upon physical events, and so on. The basis fallacy, as it is called (Observer, 1969), is common to reductionistic philosophies in science. I do not hold this position.

It is my position that psychological science, while obviously related to other sciences, is distinct from those sciences. Further, the value of psychological science depends upon a thorough understanding of *psychological* events, without embracing the events of other sciences for investigative or interpretive purposes. Specifically, psychological happenings are not viewed as caused by, or based upon biological happenings. Thus, all forms of reductionism[3] are dismissed, and individual sciences are viewed as authentic in their own right (Kantor, 1959). In other words, if psychological science developed in an effort to understand a unique set of happenings in the natural world, it must examine *those* happenings, and not the happenings already under

[3] This includes meditational models—such as input – output psychology

examination in other sciences. If this were not the case, the rationale for a science of psychology would be in question.

System Building

Thus far, I have articulated how my philosophical assumptions have led to the dismissal of dualistic and reductionistic philosophies, as well as all practices derived from these philosophies. Still, individual sciences are also evaluated in other ways. The dismissal of dualism and reductionism is necessary, but not sufficient for the development of adequate scientific systems. Beyond this, an elaborate system building procedure that provides specific guidelines for the construction, development, and examination of individual scientific systems is required (Kantor, 1959; Kantor & Smith, 1975). Importantly, the value of this procedure has not gone unnoticed by other interbehaviorists, who have implicated its utility for development in behavior analysis (Clayton, Hayes, & Swain, 2005; Hayes & Thomas, 2004). I will briefly outline some essential features of system building and the evaluation of scientific systems. First, scientific systems must be valid (Kantor, 1959, p. 50). Kantor uses the term valid to refer to what is otherwise termed internal consistency, or a lack of contradiction. Failing to appreciate the importance of validity leads to incoherent efforts toward understanding a subject matter, and threatens the value and progress a scientific enterprise may achieve.

Beyond validity, scientific systems must also strive toward significance (Kantor, 1959, p. 50). The term significance is used to describe the relationship of an individual science to the domain of the sciences more generally. When an individual scientific enterprise shares the meta-assumptions of other scientific enterprises, it is considered significant. In other words, significance is achieved by way of sharing philosophical assumptions with those of other sciences. For example, given that the sciences do not explain confrontable events by appeal to non-existent entities, the significance of a psychological system that does so is severely compromised. Many psychological systems embrace such hypothetical explanations, and it is for this reason that many view psychology as a pseudoscience. It is important to note that while significance assumes validity, validity does not assume significance. In other words, validity is a pre-requisite for significant interactions with other sciences, but validity itself does not assure significance. Indeed, there are non-scientific systems which may be considered valid, but lack significance (e.g., psychoanalysis).

Sciences must also strive toward comprehensiveness. Scientific systems that do not provide an adequate account of *all* of the events which fall within the purview of its subject matter lack comprehensiveness and leave the door open for non-scientific accounts of neglected events to flourish. In psychology, behavioristic theories are often criticized for failing to articulate an adequate account of complex behaviors such as thinking and dreaming, for example (Kantor, 1970, 1976). Comprehensiveness is not valuable by itself, however. Comprehensiveness is only valued when it is construed within a system that is both valid and significant. Thus, scientific systems must strive toward validity, significance, and comprehensiveness. It is important to acknowledge that Kantor's philosophy is rather unique in this regard, in that most other perspectives fail to articulate and fully appreciate the importance of and relations between these aims.

As I have mentioned, the concept of the past has tremendous significance for all workers in psychological science. Yet, an adequate scientific account of the relevance of our historical experiences to present circumstances has not been fully formulated. System building activities involve the examination and evaluation of scientific systems, including their assumptions and interpretations related to particular aspects of their subject matters. The following section consists of system building work in the area of memory, specifically within behavior science.

The Past

All learning processes involve historical circumstances in which behavior that had not been observed was then *learned*, as demonstrated by its performance at a later time (Johnston & Pennypacker, 1993; Pear, 2001). However, it is not exactly clear what happens when such learning takes place, or how such historical experiences operate in present circumstances. To the extent that the past has *passed*, how the past operates in the present remains to be addressed. Before solving this problem, it is important to evaluate the solutions offered by others.

The psychological literature on memory is dominated by cognitive and biological theories. Given the philosophical assumptions previously described, cognitive theories relying on hypothetical entities that cannot be observed in the spatiotemporal matrix of the natural world may be dismissed (see Marr, 1983; Watkins, 1990). As I have described herein, psychological science examines *psychological* events, rather than biological events, and thus, biological theories of memory are also dismissed as they fail to describe the subject matter of interest to psychological scientists. Of course, contemporary theories of memory often involve a hybrid of cognitive and biological theories (see Pear, 2007, p. 146 for discussion), and these hybrid theories also fall short, as they embrace *both* dualistic and reductionistic premises.

Behavior Analytic Theories

Interpretations. Skinner's system of Radical Behaviorism is widely known and recognized for its departure from many forms of traditional dualistic philosophies. For example, Skinner (e.g., 1953, pp. 23-42) criticized popular explanations of behavior for relying on hypothetical constructs, which offer little in the way of actual explanation. Similarly, Skinner (1974, p. 89) criticized copy and storage theories for offering little toward understanding complex behaviors involved in perceiving and memory. Generally, Radical Behaviorism represents a tremendous step toward identifying and removing long-standing dualistic premises from the science of behavior.[4]

Radical Behaviorism rests on the assumption that behavior is a result of an individual's genetic makeup, behavioral history, and current environment (Skinner, 1953, 1974). It is assumed that the environment selects behavior through processes of reinforcement, and that these processes alter the physiology of the organism. For example, Skinner (1953, p. 59) suggested that "The consequences of behavior may 'feed back' into the organism". Also, the stimulus events present at the time of reinforcement are said to develop stimulus control over behavior, such that the reinforced behavior is more likely to occur in the presence of those stimuli at a later time. While acknowledging respondent processes, Radical Behaviorism rests on the assumption that the environment selects behavior, and that this selection alters the biology of the organism. Skinner called this type of behavior "operant", as it *operates* on the environment (Skinner, 1953, 1969, 1974).

Skinner also addressed several important issues that are particularly relevant to our understanding of memorial behavior. One important type of memory behavior

[4] There are exceptions to this, however (see Hayes, 1994; Hayes & Fryling, in press; Parrott, 1983b).

addressed by Skinner involves seeing in the absence of the thing seen. Here, Skinner (1974) proposed that such behavior is not under the control of a current stimulus. Specifically, he stated “When a person recalls something he once saw, or engages in fantasy, or dreams a dream, surely he is not under the control of a current stimulus” (Skinner, 1974, p. 91). Rather, Skinner (1974) suggested that they are simply doing as they have done in the past, because engaging in such behavior itself is reinforcing. From this perspective someone may recall their best friend from high school because doing so is reinforcing, for example. In Skinner’s words, “We tend to act to produce stimuli which are reinforcing when seen” (1974, p. 91).

Also related to the topic of memory, Skinner (1974) addressed the problem of time in the analysis of behavior. The problem described by Skinner is that events which occur at one point in time influence our behavior at a much later time; this is the problem of temporal gaps between past and present circumstances. Here, Skinner (1974, pp. 236-237) proposed the following solution:

> The physiologist of the future will tell us all that can be known about what is happening inside the organism. His account will be an important advance over a behavioral analysis, because the later is necessarily “historical”—that is to say, it is confined to functional relations showing temporal gaps. Something is done today which affects the behavior of an organism tomorrow. No matter how clearly that fact can be established, a step is missing, and we must wait for the physiologist to supply it. He will be able to show how an organism is changed when exposed to contingencies of reinforcement and why the changed organism then behaves in a different way, possibly at a much later date.

The importance of time is acknowledged here, and Skinner's solution is to wait for the physiologist to provide a more complete account.[5] Related to the more general assumptions of Radical Behaviorism, the assumption here is that the physiology of the organism is changed at the time of reinforcement, and it is by way of the changed organism that the past is brought into the present. Similar views are maintained by other behavior analysts who have done work in the area of memory. For example, Palmer (1991, p. 263) described how one may respond to a question about what they ate for breakfast yesterday with the following:

> Since we are apparently unable to appeal to environmental stimuli to account for the difference in the responses to our question we look to the person as a variable. In a sense we are different from who we were yesterday. Presumably yesterday's exposure to scrambled eggs changed us in such a way that we respond appropriately today when asked about yesterday's breakfast.

Here, Palmer (1991) supports the notion that responding may occur in the absence of stimulation, as well as assumes that it is the organism itself that is changed through the process of reinforcement, and thus, that historical circumstances are brought into the present by way of their residence within the organism. Also supporting Skinner's assertion that organismic factors account for bringing the past into the present, Marr (1996, p. 89) stated,

> What mediates environment-behavior interactions is physiology, notably the nervous system. The study of how the nervous system is changed in behavioral processes, as Skinner asserted years ago, will provide a more complete account of

[5] In this sense a behavioral account is viewed as a proximal explanation, and the physiological account as an immediate explanation—see Pierce & Cheney, 2008, p. 4-5.

> why something that happens today may affect us tomorrow and perhaps for the rest of our lives.

These views are pervasive within the behavior analytic community. For example, in a recent treatment of memory behavior Donohoe and Palmer (2005) provided a chapter-length elaboration of memory in behavior analysis based upon input-output, mediational traditions. In their interpretation, environmental events are presumed to activate neural activity, which is said to mediate behavior (Donohoe & Palmer, 2005, p. 212). The assumption is that environmental events enter the organism, change its physiology, and subsequently regulate behavioral activity.

The analyses provided by Donohoe and Palmer (2005), and Palmer (1991) also place some emphasis on problem solving activities within the context of memory. Here, the individual is said to engage in precurrent behavior (Skinner, 1969), which then sets the occasion for remembering. For example, one might engage in various precurrent behaviors before remembering someone’s name.

Also related to memory, Skinner and Vaughn (1983) discussed improving remembering in the context of practical affairs pertinent to elders. The authors describe several common situations that elderly individuals often experience, such as forgetting someone’s name or forgetting to do something. In all of the examples, the authors provide strategies such as engaging in precurrent intraverbal behavior or arranging the physical environment so as to reduce the likelihood of forgetting. For example, the authors suggest hanging an umbrella on the doorknob as soon as one learns that it will be rainy on a given day, thus, reducing the probability of forgetting the umbrella on the way out the door.

It is not surprising that behavior analysts have attempted to analyze behaviors of the memorial sort in a number of ways, given how central such behaviors are to understanding learning. Thus far, I have focused on interpretive work within behavior analysis. I will now comment on behavior analytic experimentation in the area of memory.

Experimentation. There is a rich experimental history with respect to memory behavior in the field of behavior analysis. As early as 1938, Skinner described the assessment of forgetting after the passage of time. In this experiment four rats each received 100 reinforced lever presses, followed by 45 days of rest in the home cage, after which time he placed the organisms back into the experimental chamber under extinction conditions. The behavior of these four animals was compared to that of four other comparable animals who received only one day of rest. The rats who received only one day of rest engaged in an average of 86 responses during an hour of extinction, whereas the rats who received 45 days of rest engaged in an average of 69 responses during an hour of extinction. This experiment was taken to suggest responding is influenced by the passage of time, but that the passage of time alone does not result in forgetting.

Skinner (1950) also described this type of work in his popular article titled “Are theories of learning necessary?”. In this article Skinner criticized particular sorts of theoretical work for standing in the way of scientific progress. Within this discussion, he described how theoretical work in the area of memory had impeded progress in this important area. He went on to describe a behavioral study of memory. In this study Skinner explained how pigeons were trained to peck at a particular key at a high and steady rate. The organisms were then tested for what he called “retention” under extinction conditions at the end of six months, one year, two years, and four years. All of the birds responded during these retention tests, although less than those who were not exposed to the passage of time. This type of research is interpreted as highlighting differences in responding resulting from the passage of time.

An article by Blough (1959) which evaluated delayed matching to sample was particularly influential in the experimental analysis of memory behavior, and seems to be closely related to Skinner’s initial description of memory research. In this article the author described an experiment that involved training pigeons to respond on a match-to-sample task, wherein a sample appeared, was removed, and later, the pigeon was presented with comparison stimuli. For two of the pigeons, the delay between the offset of the sample stimulus and the onset of the comparison stimuli was gradually increased after a lengthy experience of no delay. Two other pigeons were exposed to four levels of delay in random order. Pigeons that were exposed to the constant delay showed slow deterioration in responding as the delay increased, whereas those that had random delays throughout had variable responding, at times responding with high accuracy under long delays. The researcher noted that when stereotyped responding occurred for the latter two birds, the likelihood of accurate responding increased. It was suggested that these birds developed superstitious behavior (Skinner, 1948). Blough hypothesized that the two birds exposed to the constant, gradually increasing delay did not develop superstitious behavior because of the lengthy exposure to no delay. This study constitutes the initial study in a long line of research on delayed stimulus control within the experimental analysis of behavior.

A number of others have addressed memory from this paradigm within behavior analysis. An elaborate set of experiments (e.g., Blough, 1982; Grant, 1975, 1981; Sargisson & White, 2001, 2007; White & Wixted, 1999), as well as theoretical models have been derived from this work (e.g., Nevin, Davison, Odum, & Shahan, 2007). A number of these researchers embrace the perspective of psychophysics (e.g., White, 2002), and signal detection theory (e.g., Wixted, 1998). While this line of research is behavioral in procedure, interpretive activities with respect to these investigations often embrace mentalistic constructions. For example, the perspective of psychophysics incorporates the notion of choice throughout interpretations (White, 2002). Nevertheless, experimentation based on the delayed matching to sample paradigm and related theories is thriving in the experimental analysis of behavior.

Evaluation of the Behavior Analytic Treatment of Memory

Given the philosophical perspective previously described, there are a number of limitations within the behavior analytic treatment of memory. I will organize these limitations with respect to the aims of validity, significance, and comprehensiveness. As I have described, Radical Behaviorism rests on the principles of reinforcement and stimulus control. Thus, the idea that responding may occur in the absence of stimulation (e.g., Palmer, 1991; Skinner, 1974) lacks validity. It is inconsistent to presume that behavior is occasioned by stimuli which develop evocative control through processes of reinforcement, and at the same time suggest that behavior may occur in the absence of stimulation.

Similarly, problem solving analyses of memory behavior lack coherence (Donohoe & Palmer, 2005; Palmer, 1991). In both of these models, it is presumed that the organism is changed through processes of reinforcement, and that it is the changed organism which accounts for remembering responses. Given this assumption, it is not clear why precurrent behavior would be necessary to generate remembering responses. That is to say, if the organism is different, and it is this different organism which explains changes in behavior, there is no reason to postulate precurrent stimulation as a requirement for one to engage in remembering responses. Again, these issues threaten the internal validity of behavior analysis.

Similarly, there are limitations related to the significance of behavior science. These concerns relate to the involvement of physiological events in efforts to explain *psychological* happenings. As I have described herein, this practice is derived from reductionistic philosophies. Such philosophies continue to prevail as modern substitutes for dualism. More specifically, in attempts to become more scientific much of psychology abandoned hypothetical constructs in favor of physiological constructions. Indeed, this alternative is observed in many behavior analytic treatments of memory (Donohoe & Palmer, 2005; Marr, 1996; Skinner, 1974). The practice of explaining the events of one science with the events of another has been described as the basis fallacy, and this fallacy has plagued science throughout its evolution (Observer, 1969).

Behavior analytic work in the area of memory also lacks comprehensiveness, which may explain why non-behavioral interpretations of such events continue to thrive. In the area of memory, behavior analytic work has largely been limited to analyses of delayed stimulus control (i.e., delayed matching to sample) and problem solving activities (Palmer, 1991). While both of these types of events fall under the purview of memorial activity, they are not inclusive of many events that we commonly refer to when we speak of memory. Often, we are referring to reminiscing about the past (e.g., thinking about our childhood), or remembering to complete an act in the future (e.g., remembering to take our medication at 4p.m.). Thus, it can be said that behavior analysis also lacks comprehensiveness in the area of memory.

It is important to note that philosophical work such as that pursued thus far is necessarily critical in nature (Kantor, 1953, p. 26). It does not imply a lack of respect for the work thus far completed in behavior analysis. Rather, the aim of such critical attention is to foster continued development and improvement of this work within the field of behavior analysis. In the following section I will provide an alternative perspective on memory in behavior science derived from J. R. Kantor's philosophy of Interbehaviorism and Interbehavioral Psychology, as well as unique extensions derived from these foundations.

An Alternative Interpretation of Memory

All learning involves historical circumstances, and thus, an understanding of how historical experiences operate in the present event field is essential to an understanding of all behavior. What is needed is a coherent, naturalistic perspective toward understanding the past. Toward this, I will first consider the notions of the past, future, and time more generally. Central to this perspective is the distinction between constructs and events (Kantor, 1957). Often times we confuse our manipulations, descriptions, and interpretations of the world with the world itself, with problematic consequences for scientific development. This confusion is particularly prevalent in behavior science, given several unique features of its special subject matter (Fryling & Hayes, 2009).

From the present perspective the past is viewed as a construct, and as such, is not an actual thing that currently exists in the natural world. In other words, the past exists only as a construction of the past, a *present* construction (Hayes, 1992b). When we speak of the past we do so here, now, in the present, and the same can be said of the future and of time more generally. That is to say, the past isn't an actual event that exists as something distinct from the present, and as such, we need not speculate as to its whereabouts. The past is the present, and thus, our understanding of the past requires a more thorough understanding of the present (Hayes, 1992b). If the past is the present psychological event, then our interest shifts toward understanding the present psychological event in all of its complexity.

The Psychological Event

From Kantor's perspective, psychological events are conceptualized as a continuous stream of interactions, with each event entailing its entire history up to that point. Kantor's construction of the psychological event is the behavior segment, or the interbehavioral field (Kantor, 1959; Kantor & Smith, 1975; Smith, 2006). From this perspective stimulation and responding are viewed as reciprocal *actions* which participate in a multi-factored field. That is to say, stimulation does not exist in the absence of responding, and responding does not exist in the absence of stimulation. Further, this reciprocal interaction involves setting factors, media of contact, the unique organization of all factors, and interactional history (Kantor, 1959). All of these factors are *inter*dependent, they are one interbehavioral field. Changing one factor changes the entire field, and as such, no factor is viewed as having independent, dependent, or causal status (Kantor, 1959).[6]

Of particular relevance toward understanding complex human behavior is Kantor's explicit distinction between stimulus objects and stimulus functions (Kantor, 1924, p. 47-48; Parrott, 1983a, 1983b, 1983c, 1986). One important implication of this distinction is that present stimulus objects may have the stimulus functions of objects that are no longer physically present, given a history of their occurring in relation to one another in space and time, and an individual's responding with respect to this relationship. Given the importance of these processes toward understanding behavior, Kantor (1921, 1924) proposed that association conditions are fundamental psychological processes.[7] While acknowledging that association conditions are always complex and involve a wide range of factors, Kantor (1921, 1924) described several simple associations, including those involving: stimuli and responses, stimuli and stimuli, settings and stimuli, settings and responses, settings and settings, and responses and responses (overt, implicit, and partially implicit).[8]

Given an individual's history of responding with respect to spatio-temporal relationships among stimulus objects, stimulus objects may acquire the psychological functions of other objects, such that they may *substitute* for them in their absence. When an individual responds with respect to an absent stimulus object through the stimulating action of some present stimulus object, Kantor calls that stimulating action a substitute

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[6] The interdependency notion is not to be confused with multiple dependency relations, as is more commonly understood in behavior analysis (see Parrott, 1983a).
[7] It is important to note that here the term association refers to a co-occurrence of objects/events in space and time, rather than a mental action of associating.
[8] Kantor uses the term implicit to describe responding that is with respect to stimuli that are not physically present-responding with respect to substitute stimuli (Kantor, 1924, p. 68-69, 295).

stimulus function (Kantor, 1924, p. 50-52; Kantor & Smith, 1975, p. 43). Thus, given an individual's history of interacting with A in relation to B, object A may have the functions of object B, even when B is no longer physically present. This does not depend on a physical similarity between objects A and B.[9] A is physically here and B is gone; but, B is *psychologically* present to the extent that A now has the stimulational functions of B. B is the past, operating in the present. B is A.[10]

For example, your history may have involved a date with a friend for your birthday. On this date your friend (A) may have given you a watch (B), at your favorite restaurant (C), at which a jazz band had been playing that evening (D). To be clear, this history involves conditions whereby A, B, C, and D were associated in space and time, and an individual was responding to these factors in relation to one another. In other words, the individual was interacting in and with an event field that involved all of these factors. At a later time, upon having dinner at your favorite restaurant (C), you may see your friend (A), the watch (B), and hear the jazz band (D), even though none of these factors are physically present. In other words, you may see and hear in the absence of the thing seen and heard.[11] Your favorite restaurant (C) isn't just your favorite restaurant; it is your history of interacting with it, psychologically speaking. Here, the distinction between a stimulus as an object and the functional properties of a stimulus object is made apparent. In short, we are not responding in the absence of stimulation in these circumstances. Rather, we are interacting with stimulus objects involving *present* psychological functions (Hayes, 1992b).

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[9] This is not explained by way of stimulus generalization.

[10] This has also been conceptualized as A(B), specifically with respect to equivalence relations (see Hayes, 1992a).

[11] This may also occur in restaurants physically similar to the original restaurant, for example; this is the process of generalization.

To summarize, I have suggested that memory involves a present interaction with present stimulus objects, the only stimuli we can interact with. We cannot interact with the past directly. We cannot go backward to find, or recover the past (see Hayes, 1998). We always interact with current stimuli that have current psychological functions, which must be explicitly distinguished from the stimulus objects themselves. We only have the current event field, full of presently operating historical functions. These functions are our memories.

Toward Comprehensiveness

Thus far I have reviewed some philosophical foundations regarding the system of behavior science, and conceptual issues related to the nature of the psychological event. In doing so, I have provided an alternative naturalistic account of memory, without incorporating hypothetical entities or the events of other sciences. I have described how Interbehaviorism, including work derived from it, offers a valid and significant alternative to behavior analytic perspectives on memory. In this section I will address the issue of comprehensiveness.

As discussed above, comprehensiveness is a critical aspect of all scientific systems. In its absence, alternative theories will continue to thrive, theories that embrace both dualistic and reductionistic premises. In the area of memory, I have suggested that current work does not sufficiently cover the scope of events that fall under the purview of memorial interactions. Most often, when we speak of memory we are interested in recalling events of the past or remembering to complete an act in the future. Three common memorial interactions have been addressed within the system of

Interbehaviorism, and will now be reviewed and elaborated upon in the context of my analysis thus far (Blewitt, 1983; Kantor, 1922, 1926; Kantor & Smith, 1975).

Reminiscing

Reminiscing is described as a backward looking interaction in Kantor's system (Kantor, 1922, 1926; Kantor & Smith, 1975). Reminiscing is described in this way due to its substitutional nature, that is, it involves encountering present events which have the psychological functions of past events, which are no longer physically present. These interactions involve what Kantor refers to as the three general phases of memory: a) association conditions occur, b) there is a passage of time, and c) a stimulus object has the functions of past objects; such that the past is psychologically present (Hayes, 1992b). While reminiscing interactions may occur with respect to an individual's history with present stimulus objects (e.g., you see your friend and think about the last time you saw her), it is often the case that individuals interact with stimuli that substitute for absent stimulus objects (e.g., you see your friend when you hear her voice on the phone). A common example of reminiscing occurs when individuals see their old friends, think about the games they played, and more, while passing through their childhood neighborhood. Here, the stimulus functions of the setting substitute for factors in the past.

Remembering

In contrast to reminiscing interactions, Kantor describes remembering interactions as forward looking (Kantor, 1922, 1926; Kantor & Smith, 1975). Remembering interactions are termed forward looking because they involve projecting an act into the future, to be completed at some future time. This is to say, the initial association conditions necessarily involve the construction of an act, and a specific time when that act is to be completed. Like reminiscing interactions, remembering interactions involve the three general phases of memory interbehavior: a) association conditions occur, b) there is a passage of some time, and c) a substitute stimulus is interacted with and the act is completed. Also of importance, in remembering interactions the individual may or may not actually complete the projected act, and this particular aspect of remembering involves rule-following behavior (Parrott, 1987; Skinner, 1969). Most often, remembering interactions are unique happenings, which may occur only once. For example, you remember to show up to a scheduled meeting only once, and then the engagement is over. However, other remembering interactions may be relatively less unique, but still considered remembering. Such is the case when one remembers to take their medications each day at 10a.m. and 4p.m. In this circumstance, while each response is a unique interaction with a substitute stimulus, it is one that is encountered repeatedly, with the projected response remaining the same.

To illustrate, we may make arrangements to meet a friend for dinner on Wednesday evening at 7p.m., and record this meeting on their calendar. During the time between the arrangement and the dinner we may or may not interact with the recorded stimuli that substitute for the dinner plans. For example, we might glance at our calendar before work, and this may substitute for the original plans (e.g., we might think “I have to meet Libby for dinner on Wednesday night”). Other factors may also serve as substitutes for the engagement. For example, we might pass by the restaurant on the way to work and think about the dinner plans. After the passage of some time, if a substitute stimulus is contacted, the dinner engagement is remembered; if not, it is forgotten. Whether or not the individual actually goes to the dinner involves rule-following behavior. That is, the individual may interact with substitute stimuli and engage in rule-stating behavior (e.g., think about the dinner), but may or may not follow the stated rules.

Remembering and Reminiscing Compared

While remembering and reminiscing have a number of features in common, they also have unique features. First, in remembering interactions a specific act is projected into the future. This means that during the initial association conditions a construction of a specific act yet to be completed is involved, such that at a later time it may be carried out. This is not the case in reminiscing interactions. In reminiscing interactions the individual is simply interacting with present stimulus objects that have *some* functions of past stimulus objects. Also, in remembering interactions there is a specific time at which the act is to be completed. The initial association conditions involve a construction of *when* the act is to be carried out, and this necessarily involves a construction of the future. Lastly, remembering interactions explicitly involve rule-governed behavior, whereas reminiscing interactions do not. Generally, it may be said that the constructions of time, including acts to be completed in the future, are necessarily verbal in nature, and thus, are peculiar to verbal organisms[12]. While substitute stimuli are not necessarily verbal, within the context of remembering interactions they are always substituting for verbal events, and thus, must be verbal themselves.

Memorizing

Memorizing interactions also involve three phases: a) acquisition, b) retention, and c) recall. These three phases artificially resemble the three phases of other memory interactions, and perhaps for this reason memorizing interactions may be assumed to be

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[12] Here, we are not using the word verbal behavior as Skinner (1957) did. Rather, we are referring to explicitly arbitrary behavior of the cultural sort (Kantor, 1982), developed for the purposes of substitution and reference (see Hayes, 1991).

adequate models of all memorial behavior (Kantor & Smith, 1975, p. 258). In addition to this, memorizing interactions are relatively easy to investigate, and it is likely that they are examined in more detail for this reason as well. Regardless, there are a number of important differences between memorizing and the other more common memorial interactions. Before describing these differences, I will consider the nature of memorizing interactions in more detail.

Memorizing interactions involve the acquisition of a new response, the expansion of the behavioral repertoire. Something new is developed during memorizing interactions, as implied by the term acquisition. During this acquisition, it is important to note that the individual is interacting with the same direct stimulus, in a repetitive manner.[13] Delays are arranged between presentations of the direct stimulus, and these are designed to test for the acquisition of the response to be memorized. Each interaction with the direct stimulus serves as a means by which an elaborate response is acquired, and also by which its acquisition is demonstrated. For these reasons memorizing interactions may be considered repetitive acts (Kantor & Smith, 1975, p. 258).

There are a number of important differences between memorizing and the other two memorial interactions. First, in the other interactions the individual is not developing a new response, no response is being added to their repertoire. It is the stimulus functions, particularly of the substitutive sort, which are being developed in reminiscing and remembering. In neither of these interactions is one engaging in a response that they didn't have in their repertoire, or that isn't, as Kantor would say, a part of their behavioral equipment (Kantor, 1924; Kantor & Smith, 1975). Also, in reminiscing and remembering

[13] Although the individual is interacting with the same direct stimulus throughout, it is important to note that their history with respect to that stimulus is evolving; thus, the word "same" should be interpreted with caution.

the individual is interacting with substitute stimuli, whereas in memorizing individuals are interacting with the direct stimulus. Further, reminiscing and remembering are delayed interactions that develop and evolve over the course of some time. Alternatively, each time the individual interacts with the direct stimulus in memorizing interactions they are completing an instance of the act.

Given these differences, memorizing interactions are particularly poor models for studying all memorial interactions. In particular, the role of substitute stimulation in reminiscing and remembering makes them entirely unlike memorizing interactions.

Forgetting

The topic of memory cannot be covered without addressing forgetting more directly. Generally, forgetting may be the result of deficient initial association conditions, by which substitutional functions of stimuli are developed, or the presence of distracting, interfering, or otherwise disruptive field factors at the consummation of the event (Kantor & Smith, 1975, p. 257). In addition to these factors, forgetting is involved with the evolution of stimulus function (Kantor, 1924; Kantor & Smith, 1975). Thus, it may be said that three general circumstances contribute to forgetting. Of course, it is likely that forgetting most often involves a unique combination of these factors, operating in a multi-factor field. I will now address each of these factors in more detail.

Deficient association conditions. Perhaps one of the most prominent factors involved in forgetting is under-developed association conditions, which fail to fully cultivate substitute stimulus functions. To explain this issue in everyday terms, we can't remember something if we have nothing to remind us of it. This factor underscores the importance of the first phase of remembering interactions. Efforts to promote memorial interactions may involve the arrangement of association conditions whereby a number of substitute stimuli are developed, increasing the likelihood of interacting with at least one them, thereby reducing the probability of forgetting (Kantor & Smith, 1975, p. 257). In other words, if only one stimulus object is conditioned to have substitute stimulus functions, it is less likely that one will interact with that one stimulus, and thus, it is more likely that forgetting will occur. In remembering interactions, for example, we might arrange association conditions whereby a number of substitute stimuli are created (e.g., notes, planners, pagers, alarms, asking friends to remind us), making the possibility of forgetting highly unlikely. For example, many of us are unlikely to complete all of our daily tasks and activities in the absence of a planner or schedule of some sort. Here, the schedule substitutes for the original arrangements.

Similarly, reminiscing interactions are fostered by taking pictures, writing in journals, talking about our experiences often, and so on. These efforts result in a number of substitute stimuli, enhancing the likelihood of reminiscing. In this case, forgetting occurs when substitute stimuli are not developed, and thus, not able to be contacted. For example, one is less likely to reminisce about a recent vacation if they have no pictures of it, have not talked about it, or have not written about any of their experiences. In the absence of stimuli that substitute for the experience, we cannot interact with it, as it is neither physically or psychologically present. The same process can be involved in forgetting with respect to remembering interactions.

Forgetting may also occur when there is a lack of clarity or completeness in the original association conditions. For example, if the act to be completed in the future is not clearly described (e.g., “do the scholarly thing”), it may be less likely that remembering occurs. Similarly, when the exact time to complete the act is not specified, it is less probable that one will complete the act at the appropriate time. For example, the phrase “due toward the end of the semester” may increase the probability of forgetting. Further, when the number of factors involved in the initial association condition is particularly high (as in compound stimuli), the likelihood of forgetting may increase. Such is the case when one must take their medication every third Tuesday, only if they have a certain blood pressure, and haven’t recently seen the doctor for anything else. This may be particularly so when aspects of the association conditions are also involved in other association conditions. In each of these examples, the initial association conditions may be considered deficient, such that forgetting is more likely to occur.

Participating field factors. Forgetting may also occur when various field factors alter the field in such a way that interactions with substitute stimuli do not occur. For example, Kantor and Smith (1975, p. 257) described how one may forget to engage in some act when they are intensely involved in some other activity. To illustrate, when studying for an upcoming exam, a student may not contact substitute stimuli related to other activities, as they may be attending only to materials which are relevant to the task at hand. Under these circumstances it is not that substitute stimuli are not present in the physical environment, or that they haven’t been developed sufficiently, but that some other factor prevents their operation as substitute stimuli. These factors may be conceptualized as setting factors, which always participate in the interdependency of factors comprising fields of interaction (Kantor, 1959; Smith, 2006).

Related to this, forgetting may also occur when one is no longer in the proximity of substitute stimuli (Kantor & Smith, 1975, p. 257). Environments with which we typically interact are full of substitute stimuli, they are full of our pasts with respect to those environments, full of memories, full of the present past. However, when we are on vacation, we may forget to make a business call because we have moved out of the range of so many substitute stimuli. Similarly, we may be less likely to engage in reminiscing interactions when we are in environments which are very dissimilar to environments with which we have a history. For example, when visiting a foreign country that is very dissimilar to one’s own, few reminiscing interactions may occur. In summary, substitute stimuli cannot operate if they are not contacted.

In efforts to prevent forgetting under these circumstances a number of interventions may be pursued. For example, when intensely involved in some other activity, memorial interactions may be preserved by deliberately reviewing various substitute stimuli in the environment. Again, it is not that substitute stimuli are not physically available, but rather, that they are not operating in a psychological sense. Here, one may be instructed to be more attentive, and explicitly trained to be so. Related to this, one may be advised to develop a number of substitute stimuli prior to leaving for a vacation. In these situations, it is not just the interaction with substitute stimuli that is important, but assuring that substitute stimuli are indeed present *and* available for interaction.

Evolution of stimulus function. Stimulus functions are constantly evolving, as individual histories with respect to them are constantly changing. As such, the evolution of stimulus function may be regarded as a condition of forgetting. Given a new history of association conditions, a particular stimulus object may be less likely to substitute for a specific event, or may do so only under more restricted conditions. For example, our favorite restaurant may have reminded us of the date with our friend, but given a new history of association conditions involving the restaurant (e.g., a recent debate with a colleague) it may be less likely to do so. In other words, the stimulational functions of the setting may evolve, and substitute for other events. In efforts to prevent forgetting, one may create association conditions whereby specific factors occur only in relation to the targeted factors for remembering and reminiscing. In other words, one may prevent stimulus functions from evolving in particular ways.

While the aim is often to preserve memorial interactions, this is not always the case. Such is the case of reminiscing interactions involving problematic histories (e.g., traumas of various sorts). In these situations the goal may be to alter the stimulus functions of various objects, events, and conditions such that forgetting is more likely. Also, it may be of interest to examine conditions under which remembering interactions are compromised, such as to prevent such conditions from developing. As I have mentioned, psychological stimulus functions are historical, and as such, their histories are always present (Hayes, 1992b, 1998). As with all psychological events, these functions are actualized under particular setting conditions. In efforts to alter such functions, one may develop a new history with respect to the stimulus event. Related to this, if particular stimuli are not contacted (i.e., avoided by the individual), the possibility of their developing a new history is not permitted, and thus, the stimulus is likely to sustain its initial reminiscing functions. Given this, it is not surprising that psychological therapists find it particularly useful to use exposure techniques in efforts to alter psychological distress.[14] Here, the relational histories of particular stimulus objects may be targeted, such that the psychological functions of those stimuli may be altered.

Conclusion of System Building

Given the importance of psychological history in behavior science, it is essential to critically examine the extent to which a valid, significant, and coherent account of the past has been articulated. I have suggested that such an account has not been articulated within psychology in general, and behavior analysis in particular, and that an alternative conceptualization derived from the philosophy of Interbehaviorism is warranted. Further, in efforts to build comprehensiveness I have reviewed Kantor's distinctions among memorizing, reminiscing, and remembering interactions. The Interbehavioral analysis described herein provides a naturalistic foundation from which future conceptual and investigative work may be pursued. Such system building efforts provide a context in which behavior science may be viewed as a valuable scientific enterprise, capable of effective interdisciplinary relations (Hayes, 2004; Hayes & Fryling, in press).

Still, investigation is an important domain of all scientific systems (Kantor, 1959). Here, philosophical assumptions and specific theories of complex behavior are used to develop hypotheses, and to examine them through experimentation. Indeed, one value of a sound philosophy is to provide a context in which unique experimental questions may be construed and tested. The following sections pertain to investigating remembering interactions.

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[14] Although this may or may not be called "forgetting" by psychological therapists; from this perspective, when stimulus functions evolve and change, and one no longer behaves as they used to in relation to a particular stimulus, we may call it "forgetting".

CHAPTER 2

INVESTIGATION

This experiment was pursued for a number of reasons. First, there are relatively few models of remembering interactions as they have been isolated and described from an Interbehavioral perspective. There is a tremendous need for memory research that goes beyond investigations of memorizing interactions. Thus, one reason the current study was pursued was to contribute to the understanding of a broad class of remembering interactions.

More generally, Interbehaviorism and Interbehavioral Psychology have made a relatively small impact on behavior science. Perhaps the reason for this is the fact that Interbehaviorism has not been accompanied by a large body of empirical research, something that behavior analysts have come to rely on in their ongoing challenge to mentalistic thinking. Thus, the current study contributes to the behavioral literature to the extent that it demonstrates the utility of Interbehaviorism for the development of unique and relevant research questions.

My goals for this experiment were to examine factors related to the development and evolution of remembering interactions, as described in the previous chapter. The study examined factors related to initial association conditions, setting factors, interbehavioral history, and the evolution of stimulus function. The study involved the three general phases of memorial interactions: a) the arrangement of initial association conditions, b) the passage of time, and c) the interaction with a substitute stimulus that calls out the remembering response. This study involved an analogue of a particular type of remembering interaction; namely one that is future directed and relatively repetitive in nature. Interactions of this type were targeted as they may be examined in repeated instances over time, as the projected act occurs more than once. A naturally occurring example of such interactions is remembering to take medications at particular intervals in which contact with time of day serves as a substitute stimulus for engaging in this activity. Before describing the methodology specifically, I will briefly outline the general factors that will be manipulated in the experiment.

Initial association conditions. Factors related to the initial association conditions were studied by developing four substitute stimuli, two of which were non-compound stimuli (e.g., “every time your pager goes off take your medication), and two of which were compound stimuli (e.g., “every time your pager goes off take your medication, only if your blood pressure is above 120/80 and you haven’t eaten sugar in the last hour.”). Interactions with respect to these stimuli were evaluated and compared throughout the experiment.

Setting Factors. Background task difficulty served as a setting factor in the experiment. The background task involved a puzzle with pieces falling at different paces to which the participant must respond. Pieces fell at a slow pace in some conditions (easy), and at a fast pace in other conditions (hard). The puzzle operated on the bottom half of the screen, while the substitute stimuli appeared in the top half of the screen (see appendix G for a picture of the experimental arrangement).

Interbehavioral history. Interbehavioral history is a pervasive factor in psychological circumstances. In this experiment interbehavioral history was evaluated by manipulating the ordering of the setting factor conditions. Specifically, one group of the participants were exposed to an easy setting factor followed by a hard setting factor, a second group hard then easy, a third group easy then easy, and a fourth group hard then hard. This way, the extent to which initial exposure to a setting factor influences subsequent performance in the absence of that setting factor can be evaluated. In other words, the extent to which a history of hard is present in easy, and easy present in hard may be evaluated (see Hayes, 1992b). Having groups that experience easy throughout, and hard throughout may provide some specific understanding of how these histories influence remembering interactions. In other words, the group arrangement allowed between subject comparisons to be made with respect to performances in different conditions at different times. Specifically, how performance in easy conditions may be different for those who have been exposed to easy first relative to those who have been exposed to easy second, and similarly for those who have been exposed to hard first relative to those who have been exposed to hard second.

Evolution of stimulus function. The evolution of stimulus function involved the exposure to components of the compound substitute stimuli in the absence of their other parts. For example, one of the compound stimuli involved a triangle, circle, square, and a diamond (see appendix H). The subject was exposed to a triangle, circle, and square in the absence of the diamond at various times throughout the experiment. Exposure to parts of these stimuli may alter the function of the compound stimuli.

METHOD

Subjects

Participants were 32 undergraduate students taking psychology courses at the University of Nevada, Reno. Participants sat at a computer station in an experimental room. The room is approximately 3 m by 2 m with a door separating it from other rooms.

The computer had a 15” screen, with a standard mouse and keyboard. A computer program written in Visual Basic .NET 2005 ran the entire experiment, and collected all data. The study was approved by the Office of Human Research Protection at the University of Nevada, Reno prior to collecting any data (see appendix I for IRB forms).

Design

A two-phase, non-repeating design was used to evaluate the influence of various factors on remembering interactions. Each phase was designed to be 35 minutes in length, totaling 70 minutes. There were four groups, which each had eight participants. Group one went through the experiment in the order of the easy condition followed by the hard condition, group two in the order of the hard condition followed by the easy condition, group three in the order of the easy condition followed by the easy condition, and group four in the order of the hard condition followed by the hard condition.

Consent and Experimenter Instructions

At the beginning of the experiment all participants reviewed a consent form outlining their rights, including their right to discontinue participating at any time if they would like (see appendix I for the description of study form). If the participant had no questions about the study, they were led to a small room where the study took place. The room contained chairs, desks, keyboards, monitors, and personal computers, which were used to present stimuli and record participant responses. Before beginning the experiment the experimenter informed the participants that all of the instructions would be shown on the computer screen, and that they would be instructed to get the experimenter at the end of the experiment.

Initial Association Conditions

All participants read the following instructions at the beginning of the experiment:

This study should take approximately 90 minutes of your time. You will receive 2 research credits and $10 for your participation. You may stop participating in the study at any time. Click OK to move on.

After clicking OK to move on, the participants read the following:

This study involves you playing a game that has two parts. The first part of the game requires you to place shapes into a puzzle. You can move the pieces around by using the arrow keys. You will get points for successfully completing rows. Click Next after you have read this.

After participants clicked Next they read the following:

You will now have the chance to practice the game, just to be sure you know how to play it correctly. Again, you use the arrow keys to move the pieces around. UP – Rotate, LEFT/RIGHT – Move Sideways, DOWN – Move down.

Click NEXT to start the practice trials.

Participants then completed two practice rows of the puzzle (see appendix D). After successfully completing two practice rows participants then read:

Click NEXT to go on to the next part of the instructions.

After clicking NEXT participants read the following on the screen:

The second part of the game requires you to respond to various shapes that will show up on the screen based on the instructions below.

Whenever you see (heart shape) type FER within 5 seconds.

Whenever you see (star shape) type PLU within 5 seconds.

You begin typing the response by pressing the space bar. Pressing the space bar will let you type in the text box. You will get points for writing the correct word in the text box at the correct time.

You will now have the chance to practice this part of the game, just to be sure you know the correct response.

Click NEXT to begin the practice trials.

The participants then began practice trials with respect to the non-compound stimuli until they completed 10 correct responses with respect to each of the two stimuli (see appendix E). No points were given for correct responding during this time. Upon making 10 errors, the participants were sent back to the relevant instructions again. Participants could go back to the instructions twice, meaning that they had a total of three opportunities to read the instructions and demonstrate the remembering responses. If they failed to meet the criteria they were removed from the study. These participants read the following:

Thank you for your participation. Please go get the experimenter. Do not hit OK.

These participants received two research credits and $10 for their participation. Those that successfully completed the practice trials read the following:

Click NEXT to move on to the next part of the instructions

After clicking next the participants read the following:

The last part of the instructions is also about the second part of the game.

Whenever you see (compound stimulus 1: 4 shapes) type DES within 5 seconds

Whenever you see (compound stimulus 2: 4 shapes) type OUL within 5 seconds

These shapes do not have to appear in any particular order or location on the screen. Whenever you see the four shapes anywhere on the screen hit the space bar and type the word. Again, you will earn points for correct responses.

You will now have the chance to practice this part of the game just to be sure you know the correct responses.

Click NEXT to begin the practice trials.

(see appendix H for picture of all of the stimuli)

Participants then practiced until they had made 10 correct responses with respect to each of the two compound stimuli (see appendix F for a picture of this). Again, upon making 10 errors the participant went through the relevant instructions again. As with the non-compound stimuli, participants had a total of three opportunities to go through the relevant instructions and demonstrate the remembering responses. If they failed to do so they were removed from the study. These participants read the following:

Thank you for your participation. Please go get the experimenter. Do not hit OK.

After successfully completing the practice trials participants read the following:

You are now ready to start the game. Please try your best.

Click START to begin the game.

The Game

After participants completed the instructions and went through the initial association conditions, they began playing the game. The game started and continued for a time period of 70 minutes. Again, for one group of participants the game involved 35 minutes with an easy task (described below) followed by 35 minutes of an hard task (described below) as a setting factor, for a second group 35 minutes of a hard task followed by 35 minutes of an easy task, a third group 70 minutes of an easy task, and a fourth group 70 minutes of a hard task as a setting factor. The puzzle (setting factor) was always on the bottom half of the screen. The puzzle never went higher than the bottom half of the screen, as the computer automatically removed rows that were too high (see appendix G for a picture of the game screen). Rows that were removed by the computer were considered bad rows, and rows that were completed by the participant were considered good rows. More specifically, when participants successfully filled a row with puzzle pieces due to their own performance it was considered a good row, whereas when rows were removed by the computer program automatically (because the pieces were getting too high) it was considered a bad row.

In the top half of the screen, puzzle pieces fell at either a slow pace, the easy task, or at a relatively fast pace, the hard task, depending on the phase. Specifically, pieces moved down the screen at the pace of eight movements every five seconds in the easy condition, and 20 movements per five seconds in the hard condition. In addition, various shapes that included prearranged non-compound substitute stimuli, compound substitute stimuli, and/or components of compound substitute stimuli appeared in the top half of the screen. There were always 4 to 6 shapes visible on the screen. Every five seconds two or more of those stimuli changed. Five seconds was the same amount of time the participants had to engage in the remembering response, and each one of these changes was considered a remembering trial. There were point boxes on the left side of the screen which displayed the accumulated points the participants had earned. One of the boxes accumulated points for performance on the puzzle, whereas the other accumulated points for correct remembering responses.

There were five trials for each of the two non-compound stimuli and the two compound stimuli during each five minute interval. This means there were 20 total memory trials during each five minute period. The exact timing of the presentation of the substitute stimuli was not pre-determined, and thus, it can be said that they were presented randomly. In other words, the exact timing of the presentations of the substitute stimuli within each five minute interval was not specifically programmed. The majority of the trials involved exposure to components of compound stimuli, and not the targeted non-compound or compound stimuli themselves. In other words, the majority of the trials did not involve the full compound stimuli or non-compound stimuli.

The two non-compound stimuli (heart, star) never appeared at the same time, and there was only one correct response on any given trial or no correct response at all. At the end of the experiment the participants viewed the following on the screen:

Thank you for your participation. Please go get the experimenter. Do not hit OK.

After this the experimenter briefly explained the general purpose of the study, if the participant was interested. The experimenter then thanked the participant for his/her participation. This concluded participation in the study.

Independent Variables

To summarize, the following factors were considered independent variables in the study: a) Initial association conditions, namely non-compound vs. compound substitute stimuli, b) Setting factors, namely easy and hard conditions, c) Interbehavioral history, namely the order of the setting factor presentations across participants, namely easy – hard, hard – easy, easy – easy, or hard – hard, and d) Evolution of stimulus function, namely, exposure to components of the compound substitute stimuli throughout the game.

Dependent Variables

The primary dependent variable was remembering performance during each five minute interval of the game, as measured by the number of times the participant typed the remembering response with respect to non-compound and compound substitute stimuli. A secondary dependent variable was the background game performance, measured as the number of rows of the puzzle the participant completed. Again, a good row was one where the participant placed all of the puzzle pieces together in such a way that they filled a row, after which the row was removed. A final dependent variable was the number of false positives with respect to non-compound and compound remembering responses. That is, how often the participant engaged in the remembering responses in the absence of the substitute stimulus as described in the initial association conditions (i.e., remembering when they “shouldn’t have”). Data were collected on both partial and full false positives. Partial false positives involved the participants typing any part of the remembering response, whereas full false positives involved the participants typing the entire remembering response.

These dependent variables were gathered in such a way that they could be evaluated within subjects. However, some of the independent variables could not be fully evaluated within subjects (e.g., the influence of interbehavioral history). Also, group comparisons were made for the purposes of evaluating overall differences between compound and non-compound substitute stimuli with respect to the dependent variables mentioned above.

CHAPTER 3

RESULTS

A total of 32 individuals participated in the experiment. The experiment involved four groups which consisted of eight participants each. The results are now reviewed beginning with the most general results, and concluding with the most specific results. Specifically, I will first outline the overall averages when the participants are considered as a whole, then compare the four groups to one another, and then describe each group and individual data within each of the four groups.

Overall Averages.

For the main measure, overall remembering responses, there were a total of 2,909 non-compound remembering responses for all subjects, compared to a total of 1,337 for compound remembering responses. Put differently, the mean number of non-compound remembering responses was 90.91 for each participant, compared to 41.78 for compound remembering responses (see figure 1). Thus, overall, more than twice as many non-compound remembering responses were made compared to compound remembering responses. When analyzed statistically, a two-tailed, repeated measures t-test revealed a statistically significant difference between non-compound and compound remembering responses (t=7.47, critical t=2.04). Given this, when looked at as a group, non-compound stimuli operated as substitute stimuli for the initial association conditions more often than compound stimuli.

False positive data were collected throughout the experiment. While both partial and full false positive data were taken, partial false positives occurred so infrequently as to not be worth analyzing. When false positives occurred, they involved the participant typing the entire remembering response in the absence of the initial substitute stimulus, rather than only part of the response. Overall, there were a total of 50 non-compound false positives, compared to 2,04 compound false positives. In other words, on average, each participant engaged in 1.56 non-compound false positives, and 63.75 compound false positives (see figure 2). When the two types of false positives were compared statistically, a two-tailed, repeated measures t-test revealed a statistically significant difference between non-compound and compound false positives (t=4.474; critical t=2.04). Thus, false positives almost always consisted of the responses initially associated with compound stimuli.

Group Comparisons

When remembering responses are compared between groups, the easy/hard group engaged in a total of 850 remembering responses (M=106.25), the hard/easy group a total of 855 (M=106.88), easy/easy a total of 1,404 (M=175.5), and the hard/hard group a total of 1,137 (M=142.13). Thus, the easy/easy group engaged in the highest number of remembering responses overall, followed by the hard/hard group, with the easy/hard and hard/easy group being nearly identical in overall performance (see figure 3).

With respect to remembering, group differences were also evaluated statistically. Specifically, two-tailed, independent measures t-tests were used to compare groups to each other. Only the easy/hard and easy/easy groups were found to be statistically different at the .05 level (t=2.272; critical t=+/-2.145). Also of interest, the difference between the hard/easy and easy/easy groups was large, although not found to be statistically significant (t=2.013; critical t=+/-2.145).

When non-compound remembering responses are examined separately the easy/hard group engaged in a total of 657 NC remembering responses (M=82.13), the hard/easy group a total of 541 (M=67.63), the easy/easy group a total of 879 (M=109.88), and the hard/hard group a total of 832 (M=104). Again, easy/easy was the group with the highest number of responses, followed by the hard/hard group in a close second. However, some differences were observed between the easy/hard and hard/easy groups when non-compound remembering responses were considered separately. The easy/hard group engaged in an average of 14.5 more non-compound remembering responses relative to the hard/easy group (see figure 4).

When compound remembering responses are considered separately from non-compound a total of 193 (M=24.13) responses were made in the easy/hard group, 314 (M=39.25) by the hard/easy group, 525 (M=65.63) in the easy/easy group, and 305 (M=38.13) in the hard/hard group (see figure 5). While the easy/easy group is again the top performer, there are some interesting changes. The group with the second highest number of responses is the hard/easy group, followed closely by the hard/hard group. The easy/hard group was the lowest performing group with respect to compound remembering responses.

When the mean remembering performance for each group is graphed over each five minute interval, group differences are most clearly observed during the second half of the experiment (see figure 6). The group completing the most number of responses is the easy/easy group, followed by hard/hard, then hard/easy, and lastly, the easy/hard group. Importantly, the overall difference between the easy/hard and hard/easy groups was very slight (totaling five responses). Although these groups were very close, the line graph displays how the setting factor change influenced responding in these two groups, at least when they are considered as a whole. Specifically, in the easy/hard group when the hard setting factor began responding decreased, and similarly, in the hard/easy group when the easy setting factor began responding increased. When looking at this graph, it seems as though part of the influence of setting factors may be related to the issue of setting factor change. That is, hard may only be hard if there was a history with an easy setting condition, and easy may only be easy if there was a history with a hard setting condition.

When the mean number of non-compound remembering responses is compared over time there is little differentiating between the groups very early, and later there are two clear clusters of groups (see figure 7). One group had a high rate of responding, and this group consisted of the easy/easy and hard/hard groups, and the other had a lower mean number of responses, which included the easy/hard and hard/easy groups. Interestingly, the mean number of responses for the easy/hard and hard/easy groups seemed to be moving toward each other and eventually overlapping. That is, the hard/easy group was improving at the same time the easy/hard group was decreasing in frequency.

The mean number of compound remembering responses over time revealed some interesting differences between the groups (see figure 8). Here, the superiority of the easy/easy group with respect to the mean number of responses is clear throughout the experiment. The other three groups were difficult to differentiate during the first phase of the experiment, and during the second phase the hard/easy group seemed to be improving, the easy/hard group clearly decreased, and the hard/hard group remained stable. With respect to compound remembering, the easy/hard group was clearly inferior during the second half of the experiment. Again, this type of pattern seems to indicate that a setting factor manipulation may be most influential when there was a history with a different setting factor.

In an effort to focus on the influence of different interbehavioral histories, remembering performances during the second phase of the study were also compared in isolation from the first phase. The easy/hard group engaged in a total of 401 remembering responses during the second phase (M=50.13), with individual totals ranging from 1-88. The hard/easy group engaged in a total of 503 remembering responses (M=62.88), and individual scores ranged from 7-114. A total of 760 remembering responses were made in the easy/easy group (M=95), and individual scores ranged from 54-130. Lastly, in the hard/hard group a total of 635 remembering responses were made (M=79.38), and individual scores ranged from 42-129 (see figure 9). As these numbers show, an easy history did not correlate with a higher performance in the hard condition; however, a hard history was correlated with a decrease in an easy condition.

When remembering performance during the second half was compared across groups, a two-tailed independent measures t-test revealed a statistically significant difference between only the easy/hard and easy/easy groups (t=-2.891; critical t=+/-2.145). The rest of the groups were not statistically different with respect to remembering performance. This is likely due to the extensive within group variability and relatively small sample size.

As mentioned above, false positives almost exclusively involved compound remembering responses (i.e., the responses that were specified with respect to compound stimuli during the initial association conditions). Participants in the easy/hard group engaged in a total number of 17 (M=2.13) non-compound false positives relative to a total of 624 (M=78) compound false positives. In the hard/easy group, participants engaged in a total of 2 (M=.25) non-compound false positives, compared to 78 (M=43.63) compound false positives. In the easy/easy group a total of 18 (M=2.25) non-compound false positives were made, with compound false positives totaling 700 (M=87.5). Lastly, individuals in the hard/hard group engaged in a total of 13 (M=1.63) non-compound false positives and 367 (M=45.88) compound false positives. Thus, there were rather large and clear differences between non-compound and compound false positive remembering responses for all groups (see figure 10).

Interestingly, those groups that started out in an easy setting factor engaged in particularly high rates of false positives (i.e., the easy/hard group and easy/easy groups) when compared to the groups that started out with a hard setting factor (i.e., the hard/easy and hard/hard groups). In fact, there were nearly twice as many false positives made by those who started in an easy condition compared to those who started in a hard condition. However, when the four groups were compared with independent measures t-tests there were no significant differences between them. Again, this is likely owing to the large amount of variability among participants.

When mean false positives are graphed over time for each group, we again see that those groups that started off with an easy setting factor generally engaged in more false positives throughout the experiment when compared to the other groups (see figure 11). Also, during the second half particularly, the hard/hard group was distinctly lower than the other groups. Viewing the data in this way provides an alternative way to evaluate the conclusions drawn from overall mean performances.

In an effort to understand the relationship between false positives and remembering performance, the mean number of false positives is graphed against the mean number of remembering responses for each group (see figure 12). As the graph shows, the easy/easy group engaged in the highest number of remembering responses, and also the highest number of false positives. However, the easy/hard group was in a close second with the total number of false positives, with a considerably lower amount of remembering responses. Thus, the relationship between remembering and false positives is not entirely clear. The hard/hard group had the second highest remembering performance, and third lowest number of false positives. Again, at least at the group level, the nature of the relationship between false positives and remembering is difficult to interpret. In other words, this relationship is rather idiosyncratic at the group level.

Figure 13 displays the mean number of rows completed for each participant. As may be expected, the easy/easy group had the highest mean number of rows completed (M=284.5). This was followed by the hard/easy group (M=246.88), the easy/hard group (M=150.75), and finally, the hard/hard group (M=107). Again, these means may be expected, as the group with two easy phases had the highest mean number of rows, followed by the two groups that had one easy condition, and lastly, the group that had no easy setting conditions.

There were interesting differences between the groups with respect to mean game performance over time. Figure 14 displays the mean number of rows completed during each five minute interval within each group. The hard/hard group engaged in relatively low rates of game performance throughout the experiment. The other three groups were overlapping during the first phase of the experiment, and the four groups were organized into two distinct clusters during the second phase of the experiment. Specifically, the easy/easy and hard/easy groups were completing many more rows of the game when compared to the easy/hard and hard/hard groups. Thus, the easy setting factor was correlated with a higher number of rows completed when compared to the hard setting factor, particularly in the second phase of the experiment.

Also of interest is the relationship between game performance and remembering responses (see figure 15). However, when comparing the relationship across groups it is difficult to assess the way in which these two factors interrelate, generally speaking. The easy/easy group had the highest number of remembering responses (total of 1,404, M=175.5), and also the highest number of rows completed (total 2276, M=284.5). The hard/hard group, with the second highest number of remembering responses (total 1,137, M=142.13), had the lowest number of rows completed in the game (total 856, M=107). The easy/hard group had a total of 850 remembering responses (M=106.25), with a total of 1,206 (M=150.75) rows completed in the game. Lastly, the hard/easy group had a total of 855 remembering responses (M=106.88), with a total of 1,975 (M=246.88) rows completed in the game. Perhaps the most noteworthy aspect of these findings is the low game performance and high remembering observed in the hard/hard group.

Within Group Analyses

Easy/Hard Group. Overall, individuals in the easy/hard group engaged in a total of 657 non-compound remembering responses, and 193 compound remembering responses. Individually, the cumulative number of non-compound remembering responses ranged from 12-130, with compound remembering responses ranging from 7-56. Thus, the general differences between non-compound and compound substitute stimuli are observed in this group. However, within the group, there was considerable variability, which is masked by the group means described above. For example, 5/8 participants (0549, 9771, 1108, 2904, and 2489) engaged in a rather high amount of non-compound remembering responses throughout (i.e., five or more responses throughout), whereas 3/8 (0469, 5832, and 6675) engaged in five or fewer non-compound remembering responses throughout. Moreover, for these three participants, their non-compound performance was always with respect to one of the stimuli. Given that each stimulus is shown five times during each five minute interval, five responses during this amount of time is maximum responding. In other words, 3/8 participants only developed non-compound remembering responses with respect to one of the non-compound stimuli. Related to this, of the 5/8 that engaged in higher amounts of remembering responses, two of those five only responded with respect to one non-compound stimulus toward the end of the experiment (participants 1108 and 9771). Thus, some participants displayed differential responding with respect to one of the non-compound substitute stimuli (see appendix A1).

It is difficult to observe any specific patterns with respect to the compound remembering performance in this group. For example, participant 1108 engaged in no compound remembering responses throughout, and participant 6675 engaged in a total of two compound remembering responses. Thus, for these two participants, it seems as though the compound substitute stimuli did not fully develop in the first place (importantly, the individuals were required to demonstrate these responses in practice, however). For those who were engaging in compound remembering responses during the easy condition, the onset of the hard condition was correlated with a slight decrease in this type of responding.

A total of 641 false positives were made by individuals in this group (M=80.13). Individual totals ranged from 5-392. When considering compound and non-compound false positives separately, a total of 624 (M=78) compound false positive remembering responses were made by participants in the easy/hard group. Individual totals ranged from 4-380 for compound false positives. These data are compared to an overall total of 17 non-compound false positives, with individual totals ranging from 0-12. For most of the participants in this group (6/8), the majority of false positives occurred during the early parts of the experiment. Specifically, an overall total of 11 (M=1.57) non-compound false positives were made during the first half of the experiment, with 6 (M=0.86) being made during the second half. With respect compound false positives, an overall total of 396 (M=56.57) responses were made during the first half of the experiment, with 228 (M=32.57) being made during the second half of the experiment (see figure 16). Interestingly, two of the participants (1180 and 9771) only engaged in a total of 5 false positives throughout the experiment. Indeed, there was considerable individual variability with respect to false positives (see appendix B1 for individual graphs).

The mean number of false positives during each five minute interval was also evaluated (see figure 17). The highest mean number of non-compound false positives occurred in the 2^{nd} and 4^{th} intervals (mean 0.38), with the lowest mean occurring during intervals 6-9, and interval 12 (mean 0). The mean for compound false positives was highest during the first interval (mean 11.13), and lowest during the 11th interval (mean 3.25). As this graph shows, there were large differences between compound and non-compound stimuli, and also, that compound false positives occurred more often during the first half of the experiment.

The relationship between false positives and remembering responses was evaluated to help understand how these two measures relate to one another (see figure 18). When participants in this group are examined individually, the relationship between false positives and remembering responses is not clear. That is, those with higher amounts of false positives did not necessarily have higher amounts of remembering responses, generally speaking. For example, participants 1180 and 9771 engaged in a low amount of false positives, whereas they had modest totals for remembering responses. Also, participant 0549 had the highest number of remembering responses, but did not have the highest number of false positives. Thus, when considered with respect to both non-compound and compound remembering responses, the relationship between false positives and remembering is idiosyncratic across participants.

However, there were many more false positives made with respect to compound remembering responses relative to non-compound. Thus, examining the specific relationship between compound false positives and compound remembering responses may help us observe some co-variation. Generally, when viewed this way, those with higher amounts of compound remembering responding also had higher amounts of compound false positives (see figure 19). More obviously, those with very few compound false positives also engaged in the smallest number of compound remembering responses (see participants 1180, 9771, 6675). Thus, there appears to be some relationship between compound false positives and compound remembering responses.

In addition to the general measures described above, it is interesting to look at the mean number of responses of both false positives and remembering over time, with respect to both non-compound and compound stimulation and responding (see figure 20). Here, the differences and relationships between the two types of responding become more obvious. With respect to non-compound stimulation and responding, there is no relationship between false positives and remembering. Alternatively, there is a relationship between compound stimulation and responding, and this relation is visible over time. As the graphical depiction represents, there is a corresponding waning of responding with respect to both compound false positives and compound remembering responses over time. Thus, it appears that false positives participate in compound remembering responses, and vice versa.

Participants in the easy/hard group completed an average of 150.75 rows during the entire game. Individual totals ranged from 37-342 rows completed. During the first half of the game, the easy condition, an average of 92.13 rows were completed by each participant, compared to an average of 58.63 rows during the second half of the game, the hard condition. Thus, there was considerable variation in the number of rows completed across participants, as well as large differences between the number of rows completed in the easy and hard conditions (see appendix C1 for individual graphs of game performance).

The relationship between game performance and remembering responding varied considerably across participants. Some participants, for example, 0469 and 5832 engaged in relatively low amounts of both game performance and remembering responding. Others, for example, 0549 and 2904 engaged in somewhat higher amounts of both remembering and game performance. Others seemed to engage in one response much more often than another. For example, 1180 engaged in much more game performance than remembering, and 2482 engaged in much more remembering than game performance. Thus, at least when both types of remembering responses are considered together, there are no consistent patterns among remembering and game performance across participants (see figure 21).

When mean remembering and game performances are plotted over time there is a gradual improvement observed with both types of responding during the easy condition, with a decrease in both with the onset of the hard condition (see figure 22). Also, in the hard condition an improvement in remembering was correlated with a decrease in game performance, and increases in game performance with a decrease in remembering. Thus, in the hard condition there seemed to be a more obvious relationship between the two responses. That is, when rows were completed remembering responses occurred less often.

Lastly, given the differential performance with respect to non-compound and compound substitute stimuli when considering remembering and false positives, it is interesting to examine the relationship between game performance and compound remembering responses. It is possible that this class of responding was more sensitive to setting factors. However, after reviewing the data, it again seems as though this relationship is rather idiosyncratic (figure 23). For example, some that engaged in high rates of game performance completed no compound remembering responses (participant

1180), whereas others engaged in a relatively high numbers of both (participants 0549 and 2904). Thus, general relationships between game performance and compound remembering responses were not observed.

Hard/Easy Group. When looked at as a group, participants in the hard/easy group engaged in an average of 67.63 non-compound remembering responses (range 0-135) compared to an average of 39.25 compound remembering responses (range 16-78). Thus, we again observe the general difference between non-compound and compound remembering responses in this group. Despite this general difference, there was considerable variability across participants. For 4/8 participants in this group (2288, 3108, 9372, and 9491) differences between non-compound and compound remembering were rather large and stable throughout the experiment. For 2/8 participants (7594 and 3831), responding was very low throughout the experiment, with compound remembering responses occurring more often than non-compound. Participant 7110 also engaged in more compound remembering responses relative to non-compound. Importantly, this participant only responded with respect to one of the non-compound substitute stimuli (NCS2), and thus, maximum responding was five per five minute interval. Thus, 3/8 participants engaged in more compound than non-compound remembering responses, although these differences were not large. Participant 7393 did not engage in any remembering responses until the 11th five minute interval, and from that point on engaged in a total of 20 non-compound remembering responses (all with respect to NCS1), and 16 compound remembering responses. Again, while general differences were observed when viewed as a group, participants in this group displayed rather idiosyncratic patterns with respect to remembering performance (see appendix A2 for individual graphs).

When mean performances with respect to both non-compound and compound remembering responses are graphed over time differences between non-compound and compound remembering are observed (see figure 24). Interestingly, while more responding is associated with non-compound remembering throughout, both types of responding gradually improved over time. The lowest mean for non-compound remembering occurred during the first five minute interval (M=1.75), with the highest mean occurring in both the 12th and 13th intervals (M=6 responses). The lowest mean for compound remembering responding occurred in the 5th interval (M=1.38), with the highest mean occurring during the 14th interval (M=4).

Participants in the hard/easy group engaged in an average of 43.63 (range 12-81) false positives with respect to compound remembering responses, and an average of 0.25 (range 0-1) false positives with respect to non-compound remembering responses. Thus, when looked at as a whole, a substantial difference with respect to non-compound and compound full false positives was observed in this group. Again, however, considerable individual variability existed between subjects (see appendix B2 for individual graphs).

When false positives during the first half of the game are compared to false positives during the second half of the game further differences are observed (see figure 25). An average of 28 compound false positives were made during the first half of the game, with an average of 15.63 being made during the second half of the game. An average of 0.13 non-compound false positives were made during each of the first and second phases of the game. Thus, compound false positives decreased by nearly half during the second half of the game. Interestingly, the second half of the game was the easy condition, and thus, one might speculate that participants had more time to engage in false positives, but this was not observed.

Still another way to look at false positives over time is to examine the mean number of false positives engaged in during each five minute interval (see figure 26). Here, the highest mean number of responses is observed in the first five minute interval with compound false positives (M=9.5). There is a gradual decrease in the number of compound false positives over time, as would be expected after reviewing the individual data. The lowest mean for compound false positives was in the 10th interval (M=0.75). The mean number of non-compound false positives ranged from 0-0.13. Thus, viewing the data this way supports the general conclusion that compound false positives occurred much more often than non-compound, and that the number of these full false positives decreased over time.

As a whole, the group engaged in an average of 62.88 remembering responses, and an average of 43.88 false positives. However, given the variability within the group, it is interesting to examine individual relationships between remembering performance and the number of false positives. When individual relationships between remembering and false positives are examined no clear patterns are observed (see figure 27), and in fact, there are some opposing relationships. For example, participant 9491 engaged in the highest number of remembering responses, but only a modest number of false positives. Alternatively, participant 3831 engaged in the highest number of false positives, but the lowest number of remembering responses. The rest of the group seemed to fall somewhere in between these two extremes.

Given the differences between non-compound and compound substitute stimuli, the relationship between compound false positives and compound remembering responses was also examined (see figure 28). However, there were no clear patterns again. For example, participant 3831 engaged in the highest number of compound false positives, but had a relatively low number of remembering responses. Alternatively, participant 7110 had the highest number of compound remembering responses, but only a modest number of compound false positives. Again, the relationship between false positives and remembering is not clear, but rather, idiosyncratic across participants.

An average of 246.88 rows were completed by each participant throughout the game (range 123-327). When the first half of the game (hard condition) is compared to the second half (easy condition), averages of 99.38 (hard) and 147.5 (easy) are obtained. Thus, as would be expected, more rows were completed during the easy condition when compared to the hard condition. Interestingly, these differences were observed despite the possibility of habituation to the game over time. That is, easy was higher, even though it occurred second.

Another way to look at game performance over time is to examine the mean number of rows completed during each five minute interval. Figure 29 displays a graphical depiction of this over time. The lowest mean number of rows completed was during the first five minute interval (10), with a steady increase in the mean number of rows completed throughout the hard condition and into the easy condition. A leveling off or possibly decreasing trend is observed during the latter part of the second phase. The highest mean number of responses occurred during the 10^{th} five minute interval, where a mean of 24.5 rows were completed. While there is some variability across individual participants, their graphs support this general pattern (see appendix C2 for individual game performance graphs).

Overall, no specific relationship is observed when looking at individual performance with respect to remembering and game performance in this group (see figure 30). For example, participants 3108 and 9491 engaged in relatively high amounts of both remembering responses and game performance. Alternatively, participant 7594 engaged in relatively low rates of both remembering responses and game performance. Given the differences observed with compound stimuli, it is possible that game performance had a unique influence on this type of remembering interaction. However, there were no clear patterns when this relationship was examined (see figure 31). That is, high amounts of game performance were not correlated with a decrease in remembering, and high amounts of remembering were not correlated with a decreased amount of game performance.

Another way to look at the relationship between game performance and remembering responding is to examine the mean number of responses and rows completed during each five minute interval of the game. Figure 32 displays the mean number of both types of responses over time. Generally, both slowly increased over time, with the first five minute interval being the low point for both. Again, the possibility of a unique relationship with respect to compound remembering responding was also examined. However, there did not appear to be any unique relations when mean compound remembering and mean game performance were graphed over time (see figure 33).

Easy/Easy Group. As mentioned above, the largest number of both types of remembering responses occurred in the group that experienced the easy setting factor throughout the entire game. Specifically, participants in the easy/easy group engaged in a mean of 109.88 non-compound remembering responses (range 68-139), and a mean of 65.63 compound remembering responses (range 5-118). Thus, while this group was associated with the highest means of any group, the large difference between non-compound and compound remembering responses was still observed. When mean remembering performance was looked at over time, a steady increase is observed with both non-compound and compound remembering responses, with the increase being notably slower for compound remembering (see figure 34).

When looking at individual remembering performance within this group, there is some homogeneity relative to other groups. For 4/8 participants (8691, 0256, 5293, and 9809) non-compound remembering was perfect (10 responses/5 minute interval) for 10 or more of the five minute intervals, with compound remembering responding being at or above 5 for 10 or more of the five minute intervals. For these individuals responding didn’t always start out high, but it increased rather quickly. Alternatively, 3/8 participants displayed a rather high amount of non-compound remembering, with 8 or more five minute intervals having 7 or more non-compound responses (participants 9157, 3696, and 3661). However, for these three participants compound responding did not improve over time, but rather, remained relatively low or actually decreased over time. A final participant, 2268, only responded with respect to non-compound stimulus two, and often engaged in maximal responding with respect to that stimulus (5 responses per five minute interval). Generally speaking, differences were observed between the two types of stimuli, and half of the participants engaged in relatively high rates of compound remembering responses (see appendix A3 for individual remembering graphs).

With respect to false positives, some general patterns are immediately apparent. First, false positives occurred almost exclusively with compound responses. Second, many more false positives occurred in the beginning of the experiment when compared to the second half of the experiment. Specifically, an average of 87.5 false positives were made with respect to compound responses (range 4-279), compared to an average of 2.25 non-compound false positives (range 0-8).

When the number of false positives is compared across the two phases of the experiment, an average of 57.88 compound false positives were made during the first phase of the game, with 29.63 being made during the second half of the game. When considering non-compound false positives, an average of 2.13 were made during the first half of the game, with 0.13 being made during the second half of the game. Thus, there were far fewer false positives made during the second half of the game (see figure 35).

False positives were also evaluated by looking at the mean number of false positives made during each five minute interval over the course of the experiment (see figure 36). When viewing the data this way a gradual decreasing trend is observed with respect to compound false positives. The highest mean number of compound false positives occurred in the first two five minute intervals (both having a mean of 10.5), with the lowest occurring during the 13^{th} interval, which had a mean of 1.88 compound false positives. Again, while there is variability across individual participants, generally speaking, individual data are consistent with mean patterns (see appendix B3 for individual false positive graphs).

The relationship between false positives and remembering may be evaluated by looking at the group as a whole, as well as individual participants within the group. When considered as a group, an overall average of 89.75 false positives were made, with an overall average of 175.5 remembering responses. When relationships among individual participants were reviewed no immediate patterns are seen (see figure 37). For example, participant 2268 engaged in the largest number of false positives, but had the third lowest number of remembering responses. Alternatively, participant 8691 engaged in the highest number of remembering responses, but the lowest number of false positives. Thus, it did not appear that a high number of false positives correlated with a higher number of remembering responses. Furthermore, no specific interrelationships were observed when the compound remembering/compound false positive relationships were examined (see figure 38).

An average number of 284.5 rows were completed by each participant (range 99-485). As might be expected, this is the highest number of rows completed of all of the experimental groups. Figure 39 depicts the mean number of rows completed during each five minute interval. The line graph shows an increasing trend in the mean number of rows completed over time, with the highest mean occurring in the 13th interval (23.63), and the lowest mean occurring in the third interval (15.25). Thus, at least as a whole, participants interacted with the game more over time. Although there is some variability among participants, individual graphs generally support this observation (see appendix C3 for individual game performance graphs).

As a group, the high game performance was correlated with a high amount of remembering responses, as the easy/easy group had the highest numbers of both overall.

The mean number of rows completed and remembering responses are graphed over time in figure 40. As the graph shows, both performances gradually increased over time, indicating that improvement in one did not indicate a decrease in another, and vice versa. Thus, the exact way in which the puzzle influenced group remembering is not clear. It seems as though an overall increased attending to the experimental situation is observed.

The relationship between game performance and remembering responding was also examined individually (see figure 41). As with other groups, individuals in the easy/easy group did not display any general relation between remembering and game performance. Unique to this group, however, is that nearly all participants (7/8) completed more rows in the game than remembering responses.

Hard/Hard Group. Individuals in the hard/hard group engaged in an overall average number of 142.13 (range 89-236) remembering responses. When comparing non-compound and compound remembering responses, an average of 104 (range 78-123) non-compound remembering responses were made by individuals in this group, compared to an average of 38.13 (range 7-115) compound remembering responses. Thus, as with other groups, many more non-compound remembering responses were made relative to compound remembering responses.

Figure 42 displays the mean number of remembering responses made over time, that is, during each five minute interval. Mean compound remembering responses were stable throughout the experiment, hovering between 2.25 and 3.38 mean number of responses during each five minute interval. The highest mean for compound remembering occurred in the 7th interval (3.38), with the lowest mean occurring during the 2nd, 3rd, 5th, and 10th intervals (2.25). Mean non-compound remembering responses increased and then leveled off over time. Means ranged from 4-9, with the lowest mean occurring during the first interval, and the highest mean occurring during both the 8th and 14th intervals. Thus, as a whole, compound remembering responding remained low and stable throughout, with non-compound responding improving and leveling off.

There were a number of interesting patterns observed when individual data were reviewed (see appendix A4). For example, participant 2942, after starting off with low rates of responding during the first two five minute intervals, engaged in high rates of both non-compound and compound remembering responses throughout the remainder of the game. Participants 9121 and 9633 engaged in high and steady rates of non-compound remembering responding over time, with compound remembering responding increasing over the course of the experiment. Other participants (3184 and 5209) engaged in moderate (3184) to high rates of (5209) non-compound remembering responses throughout, but, alternatively, engaged in a very few, and decreasing number of compound remembering responses. Lastly, participants 1161, 6370, and 7945 displayed somewhat undifferentiated responding during the early parts of the game, with non-compound responses eventually increasing drastically, and compound responses decreasing to zero levels. Importantly, however, despite these idiosyncratic performances, all participants engaged in more non-compound responding relative to compound. Also, generally speaking, this difference was rather large and obvious.

As with the other groups, the same two general patterns are observed in the hard/hard group with respect to false positives. First, they are almost exclusively compound false positives, and the vast majority of the false positives occurred during the first half of the game. An overall average of 47.5 (range 8-120) false positives were made by each participant throughout the game. Specifically, a mean number of 1.625 non-compound false positives were made (range 0-4), and a mean of 45.875 (range 7-118) compound false positives were made.

The mean number of false positives made during the first and second half of the game was also evaluated. A mean number of 39.88 compound false positives were made during the first half of the game, with a mean of 6 compound false positives made during the second half of the game. An average of 1.13 non-compound false positives were made during the first half of the game, compared to a mean of 0.5 non-compound false positives during the second half of the game. Thus, the number of false positives decreased over time for both types of responding, and a large decrease was observed for compound false positives (see figure 43).

False positives were also examined over time by looking at the mean number of false positives made during each five minute interval (see figure 44). Compound false positives were high during the first two intervals, at which point they began to decline quickly. The highest mean for compound false positives occurred in the first interval, with a mean of 9.63, and the lowest number of compound false positives occurred during the 12^{th} interval, with a mean of 0.38. Non-compound false positives were low throughout. The highest mean was 0.5, which occurred during the first interval, and the lowest mean (0) occurred during seven of the five minute intervals. When considering individual performances there was some variability across participants with respect to false positives, particularly during the first phase of the experiment (see appendix B4).

When the relation between false positives and remembering was examined, an overall mean of 142.13 remembering responses is compared to an overall mean of 47.5

false positives. Specifically, a mean of 104 non-compound remembering responses relative to a mean of 1.63 non-compound false positives, and a mean of 38.13 compound remembering responses relative to a mean of 45.88 compound false positives was found. Thus, it seems as though false positives may be related to remembering with respect to compound responding, and less so with non-compound responding.

When the mean relationship between the two types of remembering responses and false positives are compared over time there does not seem to be a particular relationship observed (see figure 45). That is, an increase in one does not correspond to a decrease in another, or vice versa. Interestingly, the high number of compound false positives at the beginning of the game did not seem to influence the number of compound remembering responses completed.

Lastly, the relationship between false positives and remembering is also examined individually (figure 46). As with other groups, there is no pattern observed with respect to false positives and remembering. For example, participant 2942 engaged in the highest number of remembering responses, but a very low number of false positives. Alternatively, participant 1161 engaged in a high number of false positives, but a low number of remembering responses. Thus, the possibility of a high number of false positives correlating with a high number of remembering responses was again not observed. Unique to this group, all participants engaged in more remembering responses than the number of rows completed. Interestingly, this is the opposite of what was found in the easy/easy group.

Individuals in the hard/hard group completed a mean number of 107 rows in the game, with individual scores ranging from 7-268. As a whole, this group completed the lowest number of rows. Figure 47 depicts the mean number of rows completed during each five minute interval of the game. There is a slight increasing trend in performance over time. For example, the lowest mean number of rows completed occurred during the first interval (M=3.25), and the highest mean occurred during the 13th interval (M=12). While an increasing trend is noted, these means were lower than those in other groups.

When looking at individual game performance some interesting patterns stand out. For example, 3/8 participants completed a very low number of rows throughout the game. Specifically, participants 1161, 5209, and 2942 completed 13, 22, and 7 rows during the 70 minute game. Thus, it may be said that these individuals interacted with this aspect of the experiment very little. However, these inferences need to be made with caution, as they may have been attempting to complete rows but simply not have been successful. Others completed a modest amount of rows (participants 9121, 58 rows, and 9633, 77 rows) throughout the game. Another 3/8 participants completed a relatively high amount of rows (participants 6370, 7945, and 3184). These participants completed 268, 255, and 156 rows, respectively (see appendix C4 for individual graphs).

When considering the relationship between game performance and remembering, again, the hard/hard group completed the lowest number of rows, but was second only to the easy/easy group in the number of remembering responses completed. In other words, the low game performance was correlated with a relatively high amount of remembering responses, overall. Specifically, individuals in the hard/hard group engaged in an average of 79.38 remembering responses and completed an average of 107 rows.

The relationship between game performance and remembering was also examined over time for this group, by plotting the mean number of each of the responses during each five minute interval (see figure 48). When looking at the data this way, a gradual increase in both types of responding are observed over time, indicating that an increase in one type of response does not necessarily involve a decrease in the other. Rather, the group appears to have adapted to the game in general over time.

When examining this relationship individually, idiosyncratic relationships between remembering and game performances are observed (see figure 49). For example, participant 2942 engaged in the highest number of remembering responses, and also completed the lowest number of rows in the game. Alternatively, participants 6370 and 7945 completed the highest number of rows, with a moderate amount of remembering responses. If any conclusion be drawn from viewing the individual data it is the following: Those that completed high amounts of one type of response (either remembering or game performance) did not complete high amounts of the other type of response, indicating, that at least in the hard/hard group, these two responses are at least somewhat incompatible.

Chapter 4

DISCUSSION

General

This experiment demonstrated some significant differences between responses to non-compound and compound stimuli, specifically with respect to the way in which they operated as substitute stimuli in remembering interactions. Non-compound stimuli operated as substitutes much more often than compound stimuli, and this difference was found to be statistically significant.

In addition to large differences with respect to remembering performance, there were also substantial differences with respect to non-compound and compound stimuli when considering the number of false positives (i.e., remembering in the absence of the substitute stimulus developed during the initial association conditions). Specifically, the majority of false positives involved responses that were associated with compound stimuli during the initial association conditions. The differences between compound and non-compound false positives were also found to be statistically significant.

While the difference between false positives is interesting and important, it is to be expected. Given that components of compound stimuli were present during the initial association conditions, it is not surprising that those components also substituted for the initial instructions (i.e., the projected response). Furthermore, individuals interacted with components of the compound stimuli in the absence of all of the parts throughout the experiment, providing ample opportunities for false positives to occur. Nevertheless, the differences observed highlight an interesting additional aspect of compound stimuli, namely that they involve more false positives, or, more memories in the absence of the initial stimulus compound. In the natural environment association conditions always involve compound stimuli, and thus, substitutional interactions become extraordinarily complex. Some factors present at one time may be present at other times, and other factors not, and thus, aspects of the factors participating in psychological fields do so in unique ways, involving complicated integrations of substitutional functions. Thus, one might speculate that responding occurs in the absence of stimulation (e.g., Palmer, 1991; Skinner, 1974), not only because of the confusion between stimulus objects and stimulus functions, but also because of the complex nature of very subtle substitutional processes.

As a whole, this experiment elucidated some important differences between compound and non-compound stimuli and the way in which their substitute stimulus functions develop and evolve over time. These issues are likely to be at the core of understanding complex human behavior, to be discussed further below.

Group Differences

The group differences with respect to remembering are interesting, and warrant further consideration. As may have been expected, the easy/easy group engaged in the highest overall number of remembering responses. However, it is interesting that the hard/hard group engaged in the second highest number of remembering responses. Conceptually, one might expect the hard/hard group to engage in the lowest number of remembering responses, but again, this was not the case.

The easy/hard and hard/easy groups engaged in nearly the same number of remembering responding, when considered as groups. What is particularly interesting is that the hard/easy group did not do as well as the hard/hard group. When looking at the mean patterns over time (figure 6), the hard/hard group improved quickly during the first phase of the game with respect to remembering, whereas the hard/easy group improved at a slower rate. Thus, these differences may be attributable to individual variability during the initial hard condition for both groups. Of course, group differences are also interrelated with the relative participation of other factors (see below). Also of interest, those in the easy/hard group did about the same as the hard/hard group during the initial phase (see figure 6).

When non-compound and compound remembering are looked at separately, the hard/hard and easy/easy groups were clearly superior to the other groups with non-compound remembering, particularly during the second phase (see figure 7). However, these same clear differences were not observed with respect to compound remembering (see figure 8). While the easy/easy group was obviously the highest performing group throughout, the hard/hard group was no longer superior to the hard/easy group with respect to compound remembering responses. In fact, the hard/easy group seemed to be improving toward the end of the experiment, and moving further away from the hard/hard. Thus, it is possible that longer experimental phases would have resulted in further differences between these two groups.

When looking at the overall means as a whole, it seems as though the groups with a setting factor change (i.e., easy/hard and hard/easy) did more poorly relative to those without a setting factor change (i.e., easy/easy and hard/hard). In other words, it seems as though that the change in the setting condition functioned as a setting factor more than the setting condition itself. Indeed, group differences became most apparent during the second phase of the game, indicating that the issue of setting change (which occurred for two of the four groups) may have been the most important factor. The possibility that the setting condition functioned as a setting factor only when there was a change is particularly interesting when one considers the conceptualization of setting factors more generally. That is, exactly what constitutes a “hard” and “easy” setting condition is not something that can be constructed a priori. Rather, setting factors, and the way in which they participate in psychological events, are also historical, their object properties being distinct from their functional properties in interbehavioral fields.

Despite these differences, only the difference between the easy/hard and easy/easy group was found to be statistically significant with respect to remembering responses. Perhaps this is not surprising, as there was considerable variability within groups, and indeed, the groups were not large.

Group differences with respect to false positives were also rather interesting. When looking at mean group differences (see figure 10), what stands out is that those groups starting out with an easy condition engaged in nearly twice as many false positives relative to the groups starting out with a hard condition. Thus, when the setting was easier, many more false positives occurred. Given this, it is possible that engaging in false positives is partially related to the opportunity to do so. That is, those who started out in hard conditions, whether they completed many rows or not, were likely to be interacting with the setting condition in some regard (even if just attending to it), and this may have participated in the overall lower number of false positives. In other words, participants starting in hard conditions may not have attended to the shapes as much as the participants in the easy conditions, and in the absence of attending to them, perceiving and responding with respect to them did not occur (see Kantor, 1924: Kantor & Smith, 1975, p. 35-38).

When looking at the relationship between remembering and false positives, further group differences are observed. The easy/easy group engaged in the highest number of both types of responding, and thus, the relationship was rather close. The other group starting out with an easy condition (easy/hard) engaged in many more false positives relative to remembering. Lastly, the hard/easy and hard/hard groups engaged in many more remembering responses compared to false positives. Thus, a specific type of relationship between remembering and false positives was not observed, but rather, seemed to be interrelated with the setting factor (see figure 12).

The groups were also different with respect to the number of rows completed throughout the experiment. The hard/hard group completed a relatively low and stable number of rows throughout the game. Interestingly, this low performance is distinct from the other three groups during the first phase, even the other group experiencing a hard condition. This difference during the first phase is interrelated with the interestingly high amount of remembering that occurred during the first phase for the hard/hard group. Another way to look at this situation is that the hard/easy group was comparable to the easy/easy and easy/hard groups in the number of rows completed during the first phase of the game. Thus, overall differences between the hard/hard and hard/easy groups are interrelated with these important differences during the first phase of the game. Also of interest, these differences participated in the unexpected high remembering performance of the hard/hard group. Thus, there appears to be some discrepancy in the sample in this regard. That is, while both of these groups started out in the hard condition, one group completed fewer rows compared to the other (see figures 14 and 15).

During the second phase of the experiment the easy/easy and hard/easy groups were clearly completing more rows relative to the easy/hard and hard/hard groups (again, see figure 14). These differences are to be expected, and confirm that it is easier to complete rows in the easy setting condition relative to the hard setting condition. However, the setting condition was not merely about completing rows. Moreover, it is difficult to determine whether the number of rows was low or high because one was actively engaged in the game, or if they were just not interacting with it at all. In other words, rows completed tells us about how the speed of the condition influenced the *number of rows completed*, but not necessarily how it influenced the overall setting. In this sense, the speed of the puzzle may have functioned as a setting factor for row completion rather than remembering performance.

Within Groups

Generally, when considering individual data within groups, important variability is highlighted. This variability was rather extreme at times, making group means difficult to interpret. Moreover, individual relationships between factors were also rather peculiar. While individual data may not have aided in making general conclusions about the experiment, it underscores the vulnerability of group means and statistical data more generally. For example, in the easy/hard group participant 2482 engaged in 392 false positives, while participant 1180 engaged in 5. Along similar lines, in the hard/hard group participant 2942 completed 7 rows of the puzzle, while participant 6370 completed 268 rows. My goal here is not to review the individual data again, but rather, to draw attention to the extensive variability in a general sense, and how important it is to consider the uniqueness of each individual's performance. Indeed, individual performances can often clarify interesting findings at other levels of analysis.

Meta-Systemic Considerations

This dissertation focused on behavioral contributions to memory, specifically, the Radical Behavioral and the Interbehavioral approaches. I have suggested that the Interbehavioral approach has distinct advantages relative to the Radical Behavioral approach, particularly when more complex human behaviors are approached. While this is an important aspect of Interbehaviorism in its own right, the Interbehavioral perspective described herein may also be utilized to integrate various other perspectives on memory. For example, one very popular memory procedure, paired-associates learning (see Pear, 2007, pp. 84-85), involves individuals memorizing pairs of stimuli (often two nonsense words), and later presenting one of the pairs and having the individual state the missing element. This type of research is largely conducted by cognitive psychologists, who embrace explicitly mentalistic philosophical assumptions, or perhaps more commonly today, hybrids of mentalistic and reductionistic premises (e.g., the "software-hardware" metaphor). However, the Interbehavioral perspective described herein provides an alternative, naturalistic way of interpreting this area of research. Specifically, the construction of stimulus substitution has much to offer interpretive work in this area. Given the centrality of stimulus substitution toward understanding psychological events of the memorial type, future system building work should be conducted with the aim to integrate other perspectives within an Interbehavioral framework. In other words, while Kantor's framework has a tremendous amount to offer behavior analysis, it also has a tremendous amount to offer the field of psychology more generally, and in particular, the topic of memorial action.

Conceptual Considerations

Setting factors. The conceptualization of the setting factor presented some interpretive difficulty in the present experiment. Indeed, it is difficult to examine the way in which the setting factor participated in the interactional field. Interbehaviorists have long cautioned about the difficulty of distinguishing between settings and stimuli (Kantor, 1924, p. 55-56; Smith, 2006). Kantor (1924, p. 56) indicates that setting factors have their primary influence on other stimuli, rather than upon their own coordinated reaction systems. Thus, while I have attempted to measure the interaction with the setting factor herein, this may have been superfluous. This is to say, the way in which the participant interacted with the puzzle by way of the number of rows completed may not be indicative of its participation as a setting factor for remembering interactions, on the contrary, it may be indicative of the extent to which the speed of the puzzle functioned as a setting factor for row completion. Thus, while I have attempted to measure the way in which the participant interacts with the puzzle, this may have little to do with setting factors with respect to remembering interactions. For example, it is possible that the speed of the pieces falling functioned as a setting factor for rows completed. Statements such as these should be interpreted with caution, however. My point is that the conceptualization of the setting factor in the present experiment presented some interpretive difficulty.

Further, the conceptualization of easy and hard warrants further clarification. What may be constructed as “hard” or “easy” by an investigator may not actually participate in the field in that way from the psychological perspective of the participating individual. The results of this experiment seem to suggest that “hard” is only “hard” when one has a history with “easy”, and similarly, that “easy” is only “easy” when one has a history with respect to hard. In other words, what may alter the field is not the history itself, but the *change* in circumstances. The remembering data described herein seem to indicate that change itself may be a setting factor, to which one eventually adapts. However, the data from the current investigation do not allow any specific conclusions to be drawn regarding this issue. Future research should examine the exact conditions in which contextual circumstances actually function as setting factors.

Future studies should attempt to construct a setting factor that the participant is required to interact with, one which is specifically interrelated with the psychological stimulus, rather than one that comprises an incompatible response. For example, participants could be required to complete a 30 minute game similar to the one described herein, with half of the participants being required to complete a very difficult puzzle for 45 minutes prior to the 30 minute game, and the other half not being required to do so. This type of setting factor manipulation would guarantee that all participants contacted the setting factor, and also focuses on the way in which it alters responding with respect to the psychological stimulus of interest. Constructing the setting factor more carefully and consistently would provide more valuable information regarding the way in which they participate in remembering interactions.

In summary, some important conceptual lessons were learned in the present experiment. While I have articulated and supported the distinction between stimulus objects and stimulus functions, the same type of distinction is warranted for other aspects of the interbehavioral field. Setting factors are not determined by their object properties, or even the way in which the organism interacts with *them.* Setting factors are functional participants in the multi-factored field, and thus, their purely psychological aspects need to be the focus of investigation. That is, as setting factors, their participation in the individuals responding with respect to some other source of stimulation is of interest.

Conceptualizing False Positives. As with all experimentation, this study examined constructions of events, or, partial happenings. For the purposes of this study, false positives were said to occur whenever the individual engaged in the remembering response in the absence of the full stimulus initially associated with the response. However, at a conceptual level, there aren’t any “false positives”. For example, this experiment found that false positives occurred much more often with respect to compound remembering responses relative to non-compound. This is not surprising, as when a compound stimulus is associated with a response in space and time, and an individual responds with respect to that compound stimulus and the projected response (i.e., the description of the act to be completed), *all* aspects of that stimulus compound are likely to develop substitutional functions. That is, each individual component of the compound stimulus substitutes for the projected act. Added to this, some of the components were similar in shape and/or color, and thus, objects that were not a part of the initial compound also developed substitutional functions by way of stimulus generalization. To be clear, these responses were called false positives for the purposes of investigation, but conceptually speaking, the individual was interacting with a stimulating circumstance, and that circumstance was acting with respect to the individual, and thus, these are not errors, conceptually speaking.

Rule-following. Earlier, I suggested that remembering interactions also involve rule-following behavior, as the individual may remember to complete an act, but may or may not actually do so. For example, we may remember to call a friend at 4p.m., but remembering this does not always involve calling our friend. In the current study all participants were given a rather elaborate set of instructions at the beginning of the experiment, which could be conceptualized as "the rules", at least from an operant perspective (e.g., Skinner, 1969). However, in understanding this operation from the Interbehavioral perspective described herein, the stimulus objects (i.e., the shapes), upon a spatiotemporal association with the instructions (i.e., the rules), substituted for the instructions in the absence of them. In other words, the shapes acquired the stimulational functions of the instructions, such that the individual interacted with the instructions, psychologically speaking, when they interacted with the shapes. When the experiment began individuals also received points for engaging in the correct responses, and, as such, those responses and stimulational circumstances also acquired the functions of the points. In other words, those stimulational circumstances (including the stimulational products of completed responses), at a later time, became the points as well as the instructions.

However, a large number of false positives occurred throughout the experiment, particularly with respect to compound remembering responses. These responses also occurred as reciprocal interactions with stimulational circumstances, and when the addition of points did not occur with respect to these circumstances, they not only failed to acquire the functions of points, but they also began to substitute for the absence of points. Added to this, aspects of these stimulational circumstances also participated in the "correct" compound stimuli, and as such, the overall functioning of these stimuli was compromised over time. That is, all of the parts of the compound stimuli occurred in the absence of the whole, whereby, the individual parts no longer substituted for the original rules and, as such, what is described in the operant literature as rule-following decreased.

Still, for some participants, compound remembering responding persisted over time, at least to some degree. In these cases the participant must have been attending to, and interacting with the whole stimulus compound, rather than only with its parts, whereby it may be concluded that the individual parts of compound stimuli developed relatively less substitutional functions than the whole, and it is the entire stimulational setting which developed substitutional functions. However, few participants did this well, and this is not surprising. Again, individuals were exposed to components of the compound stimuli in the absence of the whole stimulus compound throughout the experiment, and thus, this history became rather convoluted, even when correct responding did occur.

To be clear, I am suggesting that psychological events always consist of a reciprocal interaction between stimulation and responding, an event that always participates in a field of various factors. Thus, I do not hold the position that individuals learn a repertoire of “rule following”, and that it is this repertoire which determines whether or not rule following occurs. Rather, each and every psychological event involves specific psychological circumstances, and these are the adjustments of focus. When considering complex human behavior, stimulus objects *are* words, psychologically speaking. Stimulus objects substitute for their histories, and their histories are often verbal in nature. When one engages in “rule following” they aren’t following rules, they are interacting with a verbal stimulus. Importantly, this perspective explicitly avoids any possibility of dualistic interpretations. Indeed, the extent to which stimulus substitution accounts for what is termed rule-governed behavior is almost entirely overlooked in behavior analysis (see Parrott, 1984, 1987 for exceptions).

Limitations

The current experiment used relatively small groups when considering the nature of group design experiments. As such, statistically significant differences between groups were not as prevalent as they may have been if larger groups were used. However, using large groups to undermine individual variability is generally inconsistent with my views as a scientist. Indeed, several behavior analysts have suggested that statistics are not useful tools in behavioral research, and for this reason, they are largely avoided by behavior analysts (e.g., Baer, 1977; Hopkins, Cole, & Mason, 1998; Johnston &

Pennypacker, 1993; Michael, 1974; Sidman, 1960). Thus, while statistical analyses were conducted, the fact that significant differences were only found for two groups should be interpreted with caution. Researchers with interests in the behavior of groups (e.g., sociologists, public health researchers, etc.) may be interested in conducting studies of this sort with a much larger number of subjects. This is not to say that statistical differences are not important, but they are not the focus of this particular investigation.

Moreover, including 32 subjects may have made individual analyses of the data unnecessarily complex, and perhaps even have distracted attention from important issues. Thus, while future researchers might want to consider a larger n size, others may want to consider more detailed studies utilizing fewer participants than were involved in the current study (e.g., two groups of 10). Perhaps detailed, single-subject analyses such as these will set the occasion for more successful group design studies in the future.

A more general limitation is that the current study may have focused on too many factors, resulting in a limited ability to understand the way in which specific factors had a unique influence on remembering interactions. In the present study, the type of substitute stimulus developed (non-compound and compound), the speed of the background task, the ordering of exposure to the background task, and exposure to elements of the compound stimuli in the absence of the whole compound stimulus were manipulated. As a result, for example, while it is clear that compound stimuli did not operate as substitutes as effectively as non-compound stimuli, it is not clear whether or not this is a result of differences between non-compound and compound stimuli, or whether it is attributable to the exposure to components of the stimulus compounds in the absence of the whole compound stimulus. Future studies could focus on this issue specifically by evaluating remembering with respect to non-compound and compound stimuli in the absence of exposure to parts, and also, by evaluating responding with respect to two compound stimuli, under conditions in which their parts appear separately and not. This way researchers could better understand the particular factors influencing both remembering and forgetting over time. Other examples with respect to the other factors manipulated, could also be developed and pursued (e.g., only manipulating the setting factor).

Finally, factors related to participant characteristics involve the general lack of motivation to perform during the experiment. University policy prevents participants from being rewarded contingent on any specific performance, as this is viewed as a type of coercion. Thus, participants had no reason to attempt to do well in the experiment. All of the participants were undergraduates, who received 2 psychology extra credits and $10 for their participation, regardless of their performance. Thus, some participants were engaged in the study for only a few minutes, for which they were given two credits and $10. It is difficult to determine how this problem can and should be overcome in the absence of altering the IRB policy, or by pursuing deception.

Conclusions

In summary, this dissertation had three primary aims. First, I aimed to conduct a critical analysis of the Radical Behavioral perspective on memory, with the goal of understanding aspects of it that required further system building efforts. Second, I described a comprehensive Interbehavioral alternative to the Radical Behavioral perspective on this type of activity, an alternative that did not invoke dualistic or reductionistic explanatory constructs. Third, I developed an experimental model of remembering interactions, and evaluated several factors which may influence remembering and forgetting over time. As I have described herein, my aims have been accomplished.

I have advocated for a comprehensive field approach throughout this dissertation. However, some further comments are warranted to prevent the possibility of confusion. I have constructed multiple aspects of the field for investigative purposes. However, while I have manipulated isolated aspects of the field, it is important to be clear that it is always the *whole* field which is altered when any factor is manipulated. That is, no aspect of the field has causal power. However, fully embracing this perspective leaves one with little ability to say anything specific about the field. That is, if it is always the *whole* then it is *never* the parts, and as such, speaking about the parts becomes problematic. Nevertheless, I have attempted to speak about the parts herein, with the hope that I might be able to better understand how they participate in the whole. Despite this, it is never helpful to confuse our investigative constructions with the event of interest (Kantor, 1957); and these comments are aimed at preventing this possibility from occurring. We must be sensitive to the whole field.

There are a number of important implications of this dissertation. Some of the more general implications pertain to the constructions of psychological events, including how they are approached and interpreted. Some of the most naturalistic *experiments* continue to be *interpreted* within a dualistic and reductionistic philosophical framework. Within the Radical Behavioral system these philosophies have been embraced either implicitly or explicitly, preventing a natural science of psychology from moving forward in a coherent manner. Indeed, no amount of experimental data will ever overcome philosophical missteps. Thus, the current dissertation provides an example of how system building might be conducted with the aim of removing problematic philosophies, as we move toward an integrated, comprehensive approach to psychological events.

Other implications pertain to future research, including studies of both the basic and applied types. Future studies should continue to aim to understand the way in which various factors participate in remembering and forgetting, their aim being to guide future applied research, and ultimately permit an understanding of socially important behavior. Many of the most significant problems facing our society involve substitutional functions operating over time. For example, diet and exercise behavior, which are of utmost importance toward healthy living, both involve remembering over time. Thus, understanding conditions in which remembering repertoires persist and diminish over time has important social implications.

Still, this experiment is an analogue of remembering interactions, and as such, its outcomes pertain only to the analogue from which they were derived, and not to some other events. The outcomes (constructions) of this dissertation apply only to this dissertation, and the extent to which they may apply to other circumstances is yet to be realized. That is, the constructions developed herein cannot be imposed upon other events a priori, but rather, must be discovered. Indeed, the value of an analogue is limited by the extent to which its findings can be verified in more loosely controlled natural settings (Kantor, 1959).

This dissertation evaluated the important area of memory in behavior science, and evaluated the influence of various factors on remembering interactions over time in an analogue experiment. To the extent that behavior analysis has failed to approach the important area of remembering in a naturalistic, coherent manner, this dissertation contributes to the behavioral literature in a general sense. Furthermore, experimental models with an Interbehavioral foundation are rare, and thus, the experiment contributes to the literature to the extent that it demonstrates the utility of the Interbehavioral perspective toward understanding important complex human behavior. It has been suggested that Kantor's Interbehavioral Psychology may guide behavior analysis as it approaches more complex phenomena (Morris, Higgins, & Bickel, 1982), and the theoretical and investigative work described herein provides further support for that claim. While Interbehaviorism and Interbehavioral Psychology have not gained widespread acceptance when compared to Radical Behaviorism, it seems likely that the field will acknowledge the utility of the Interbehavioral perspective as behavior analysis progresses towards a more contextual understanding of complex human behavior. It was my aim to demonstrate the value of the Interbehavioral perspective for system building in behavior analysis, and to exemplify how that perspective might be useful in the conceptualization of experimental preparations of important psychological events.

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Figure 1

Overall Mean Number of Remembering Responses

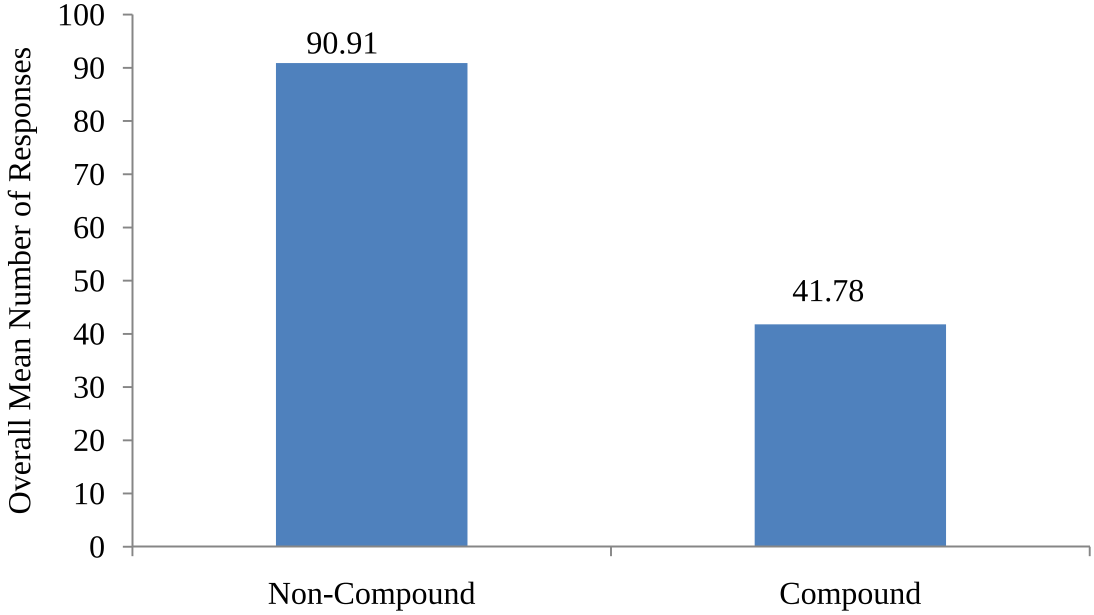
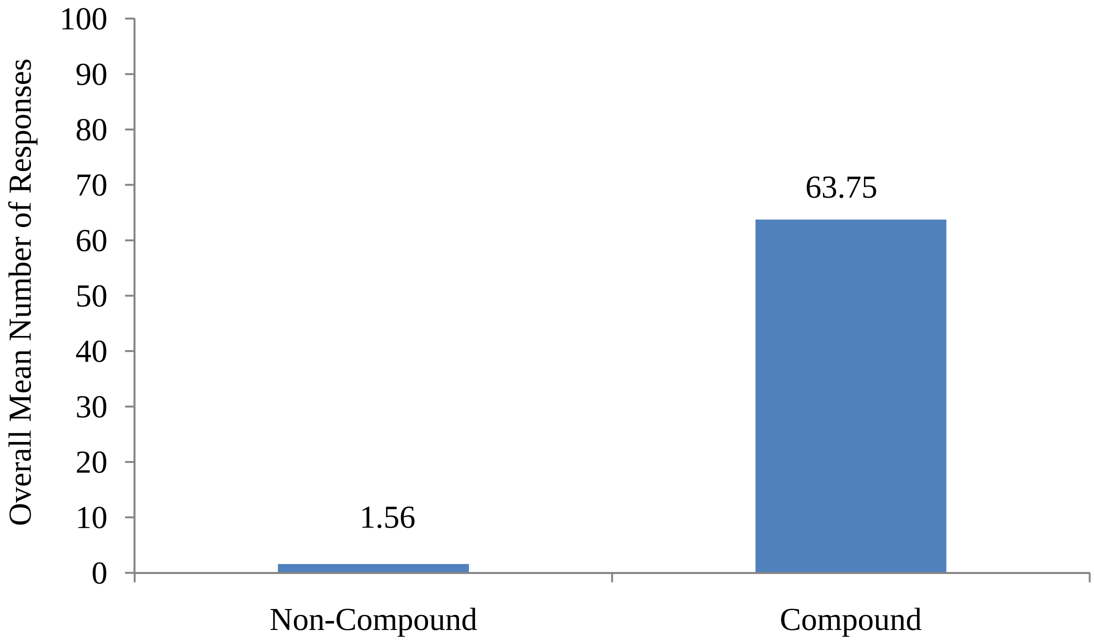


Figure 2

Overall Mean False Positves Non-Compound vs. Compound



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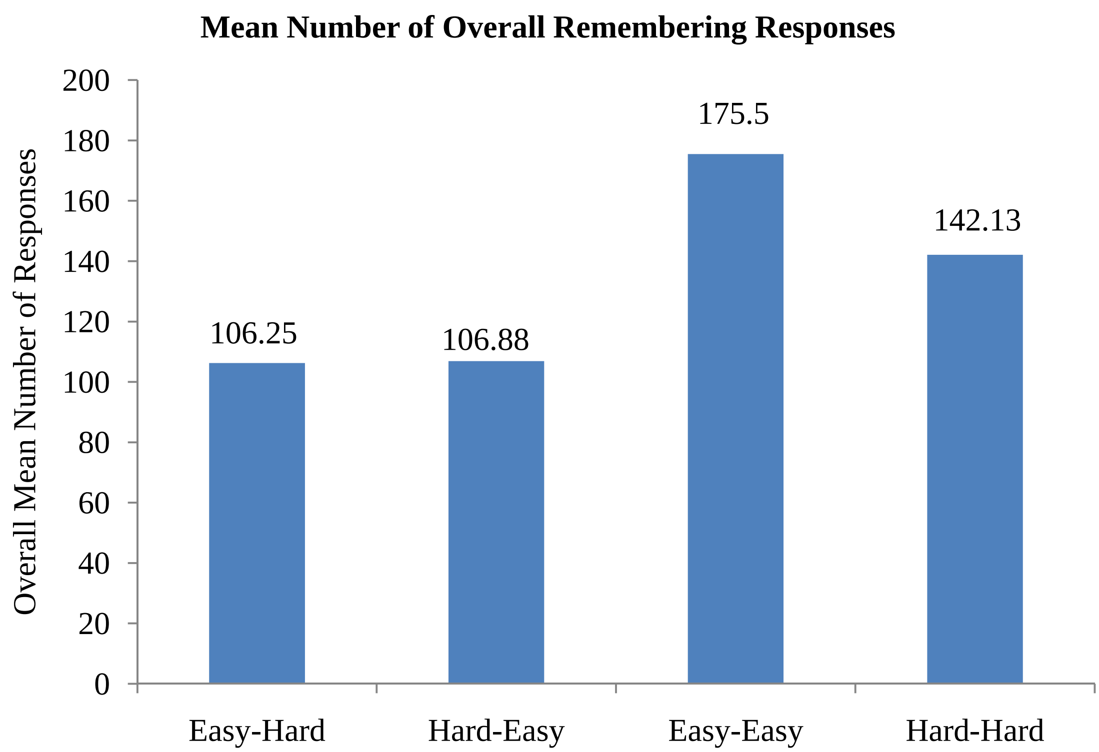

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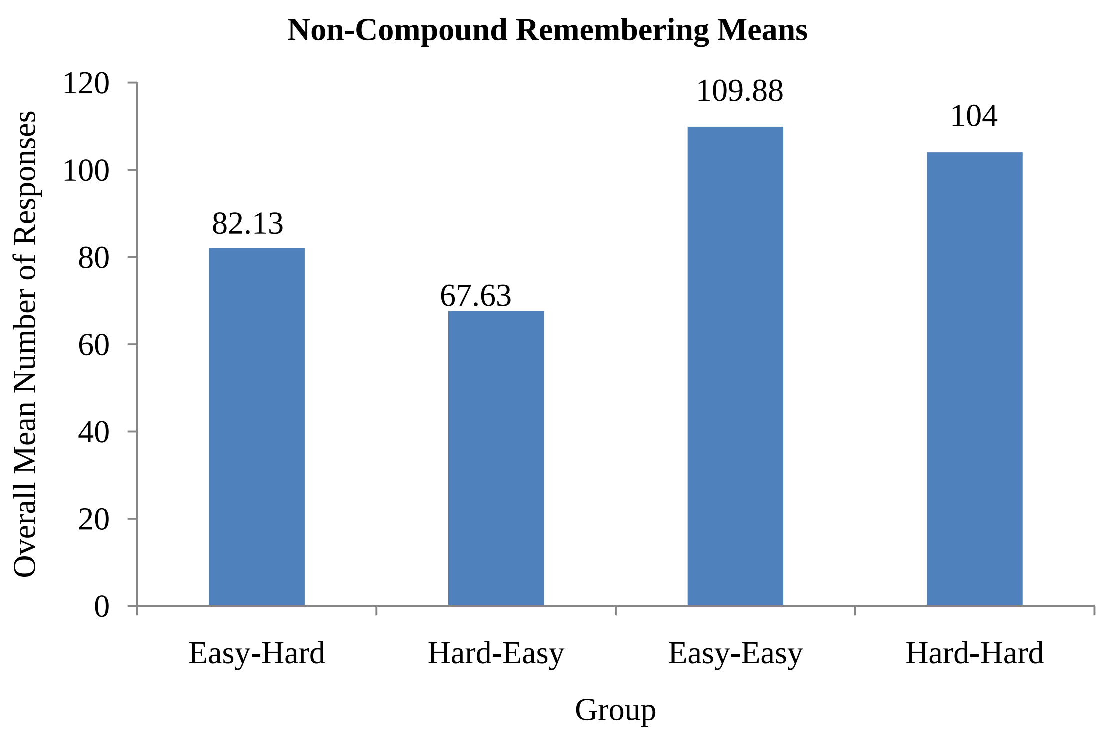

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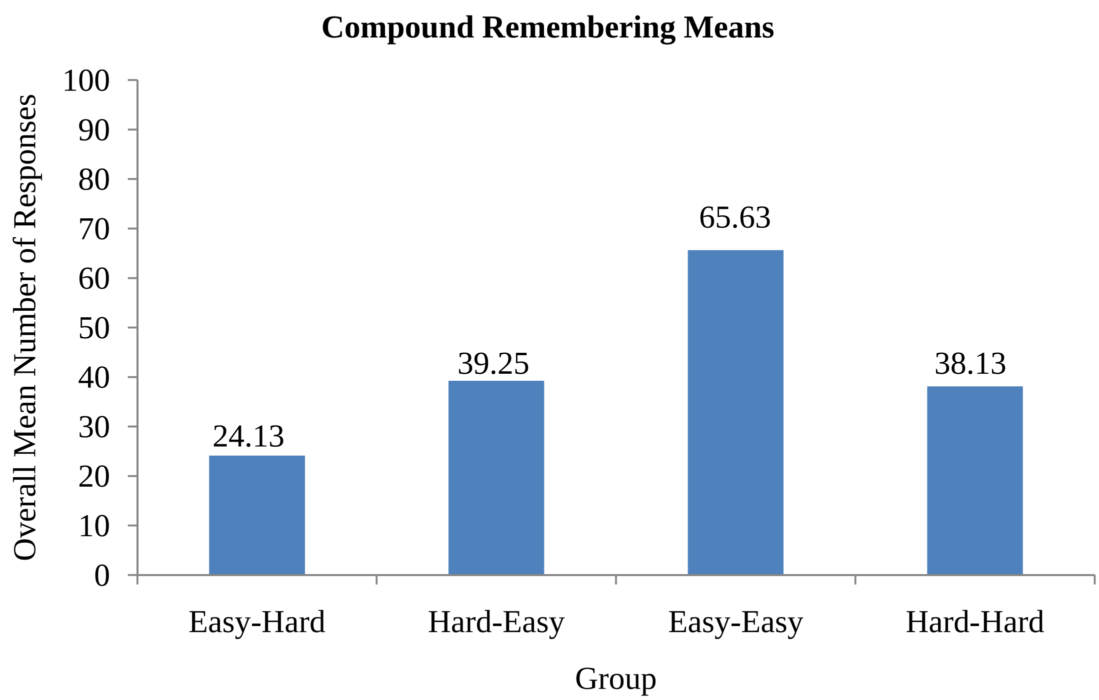

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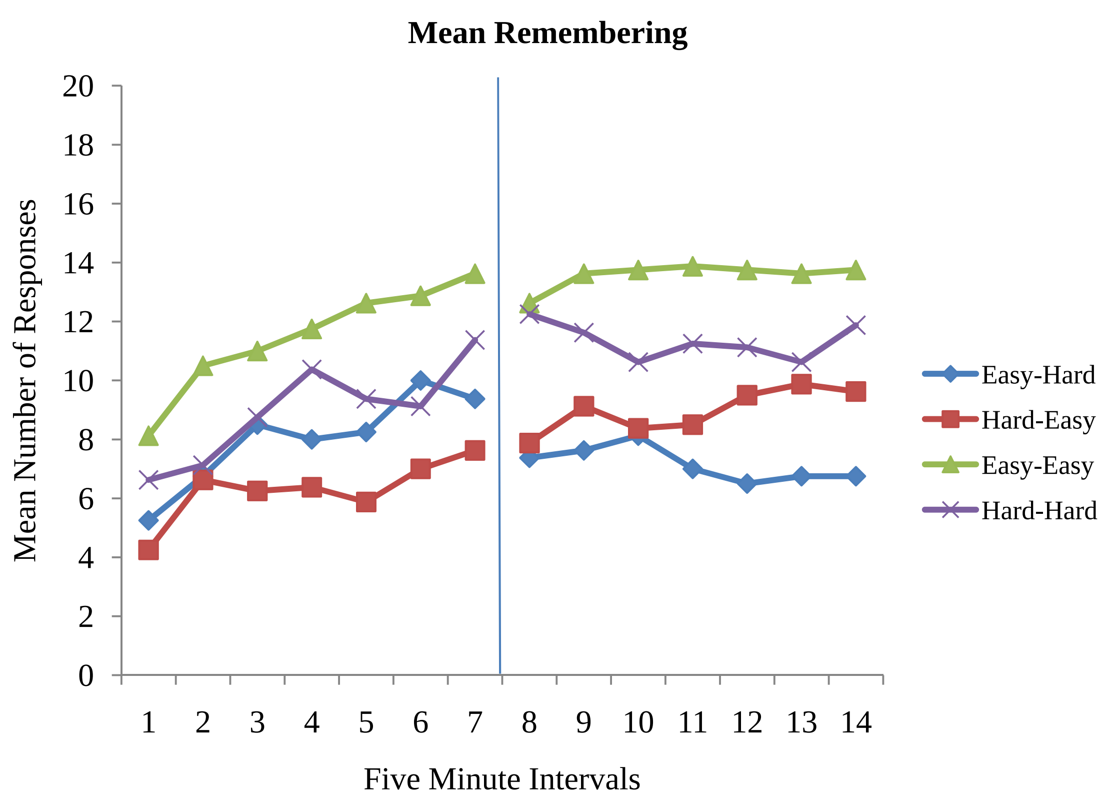

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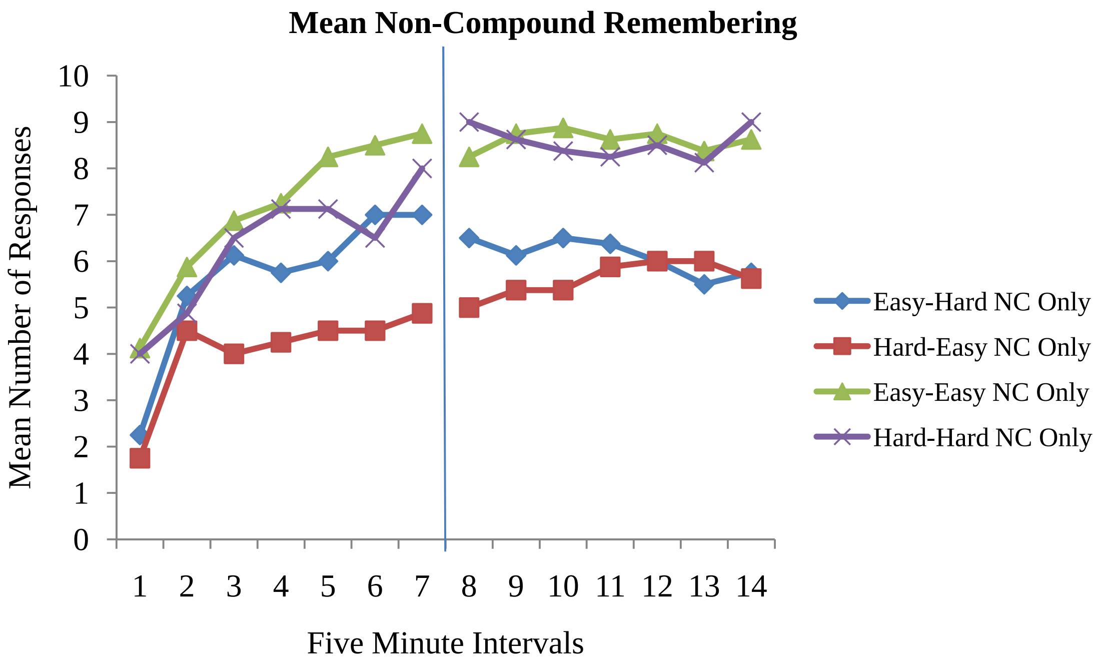

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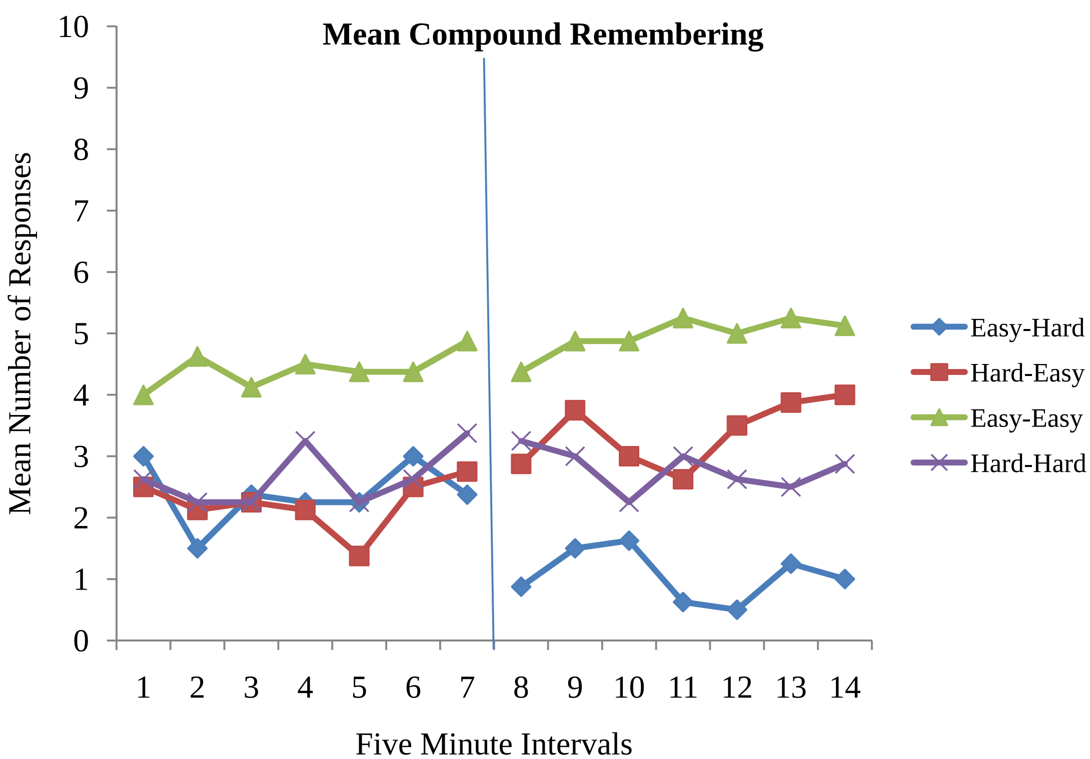

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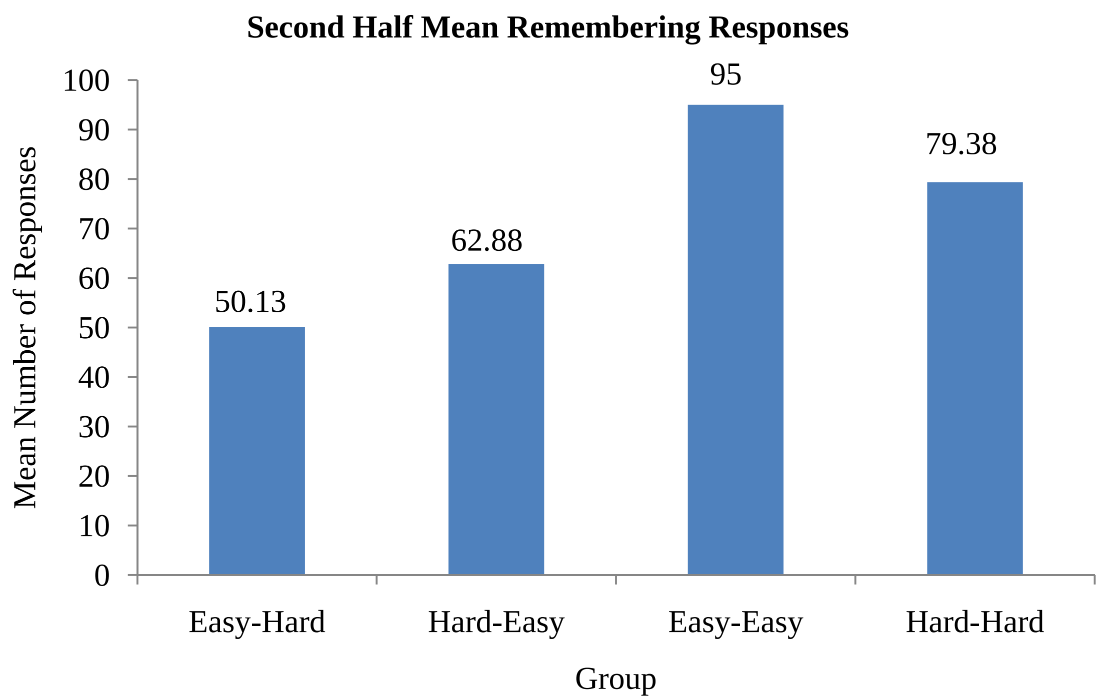

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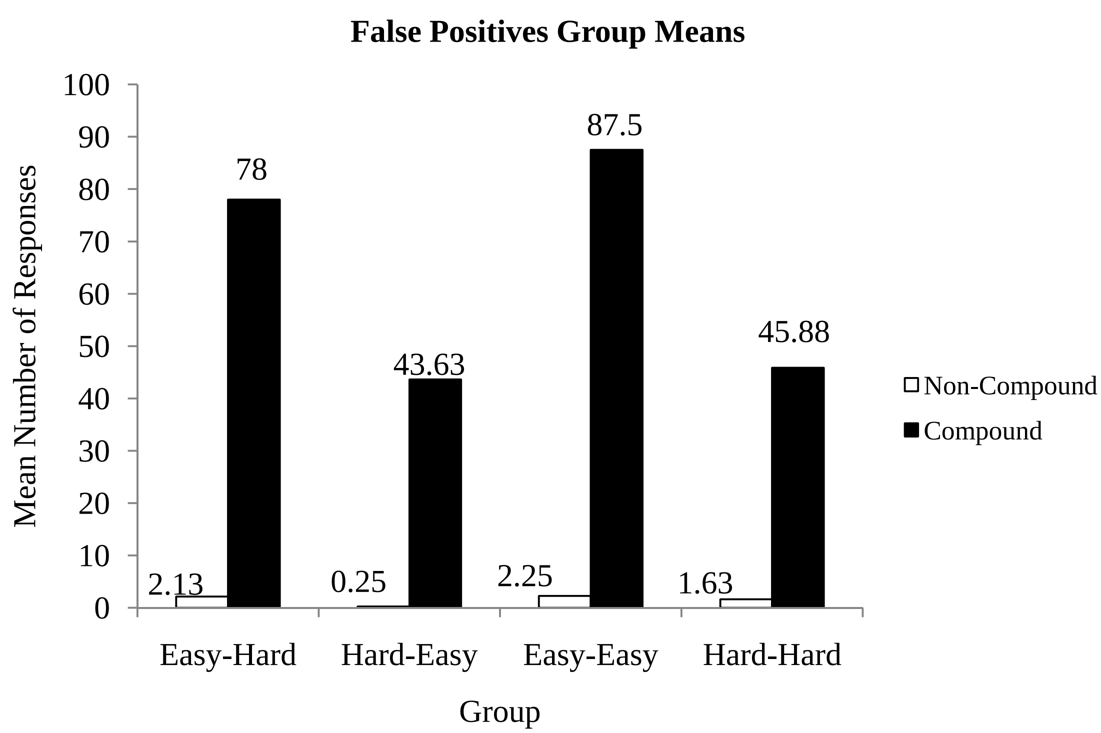

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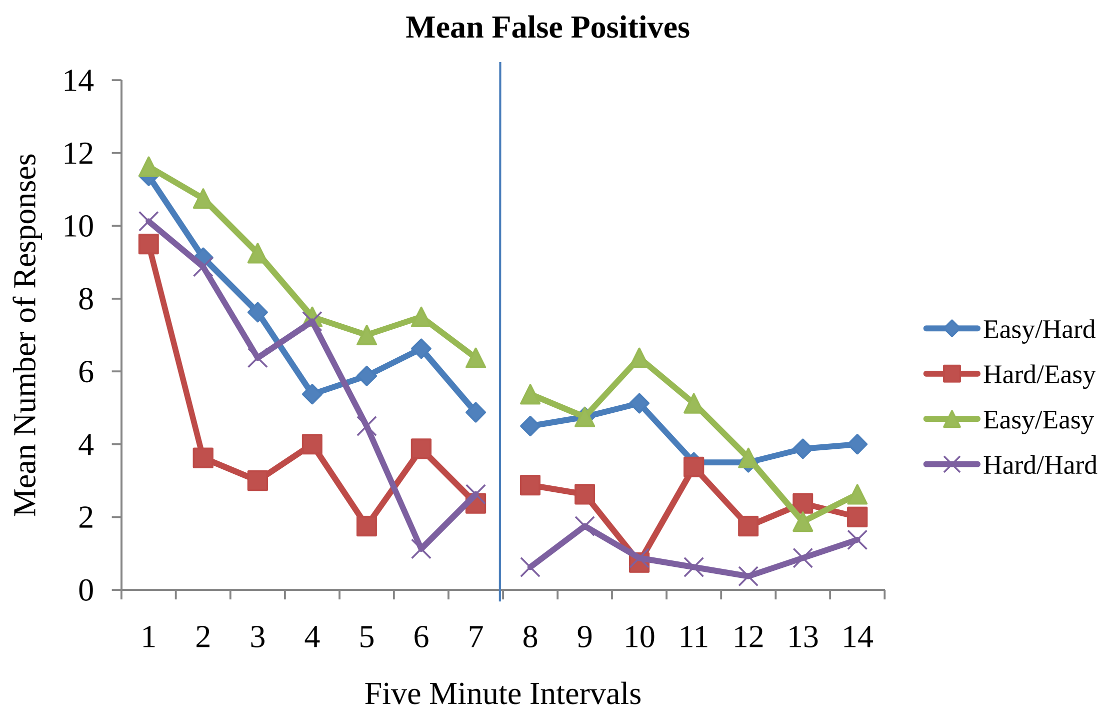

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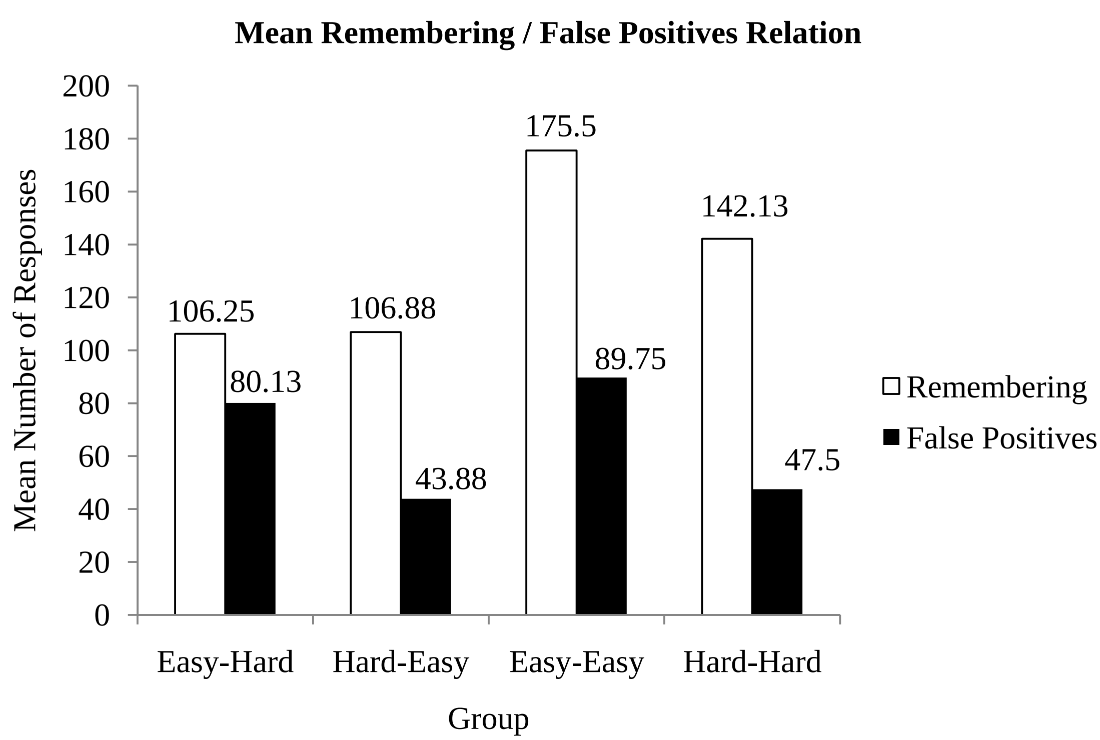

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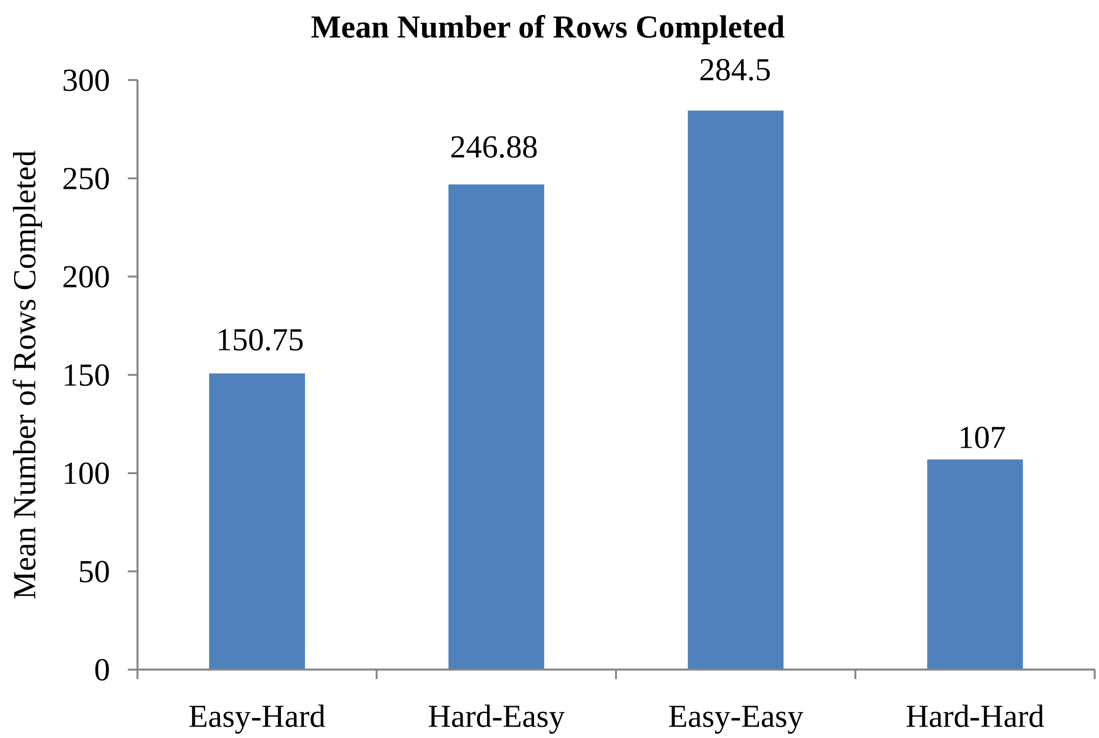

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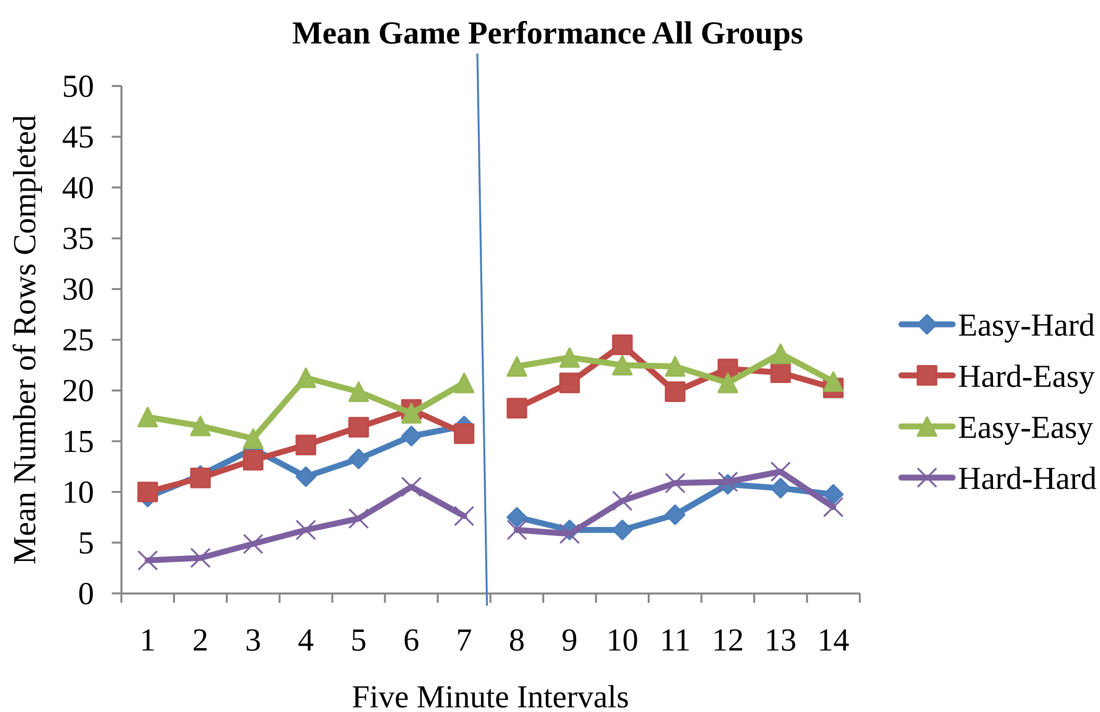

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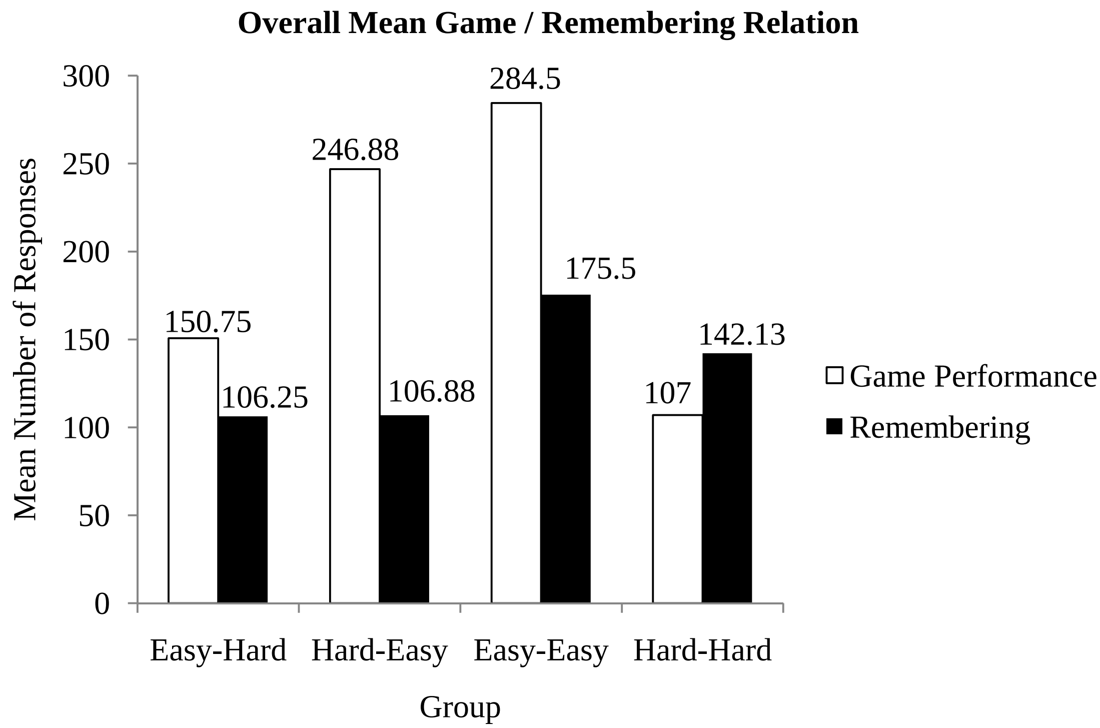

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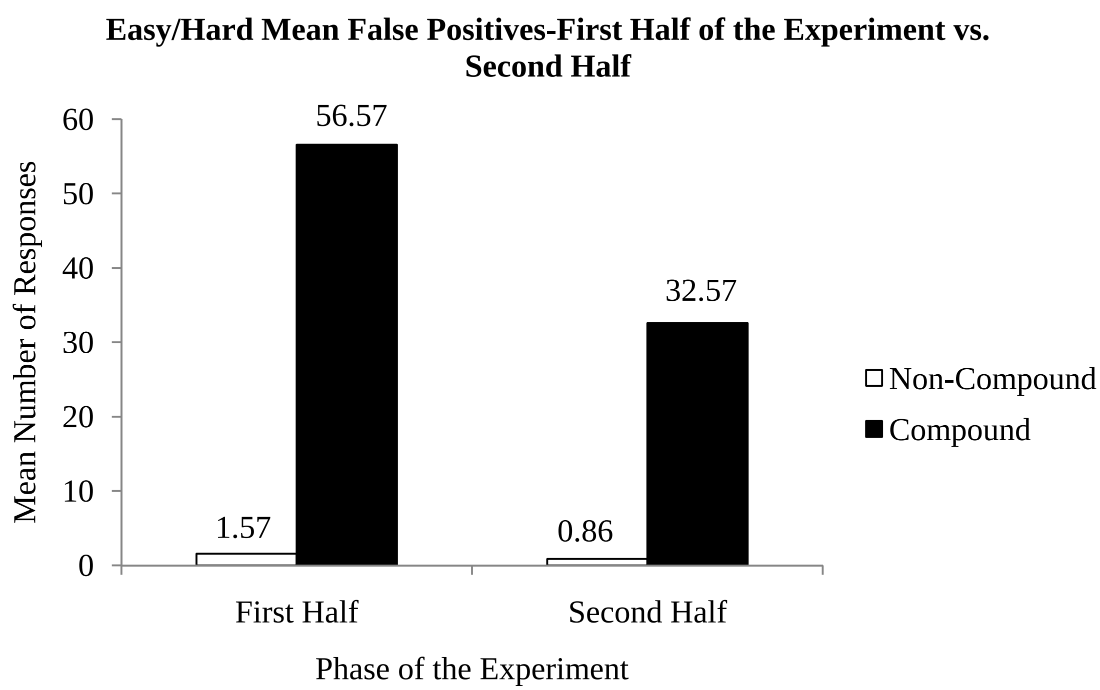

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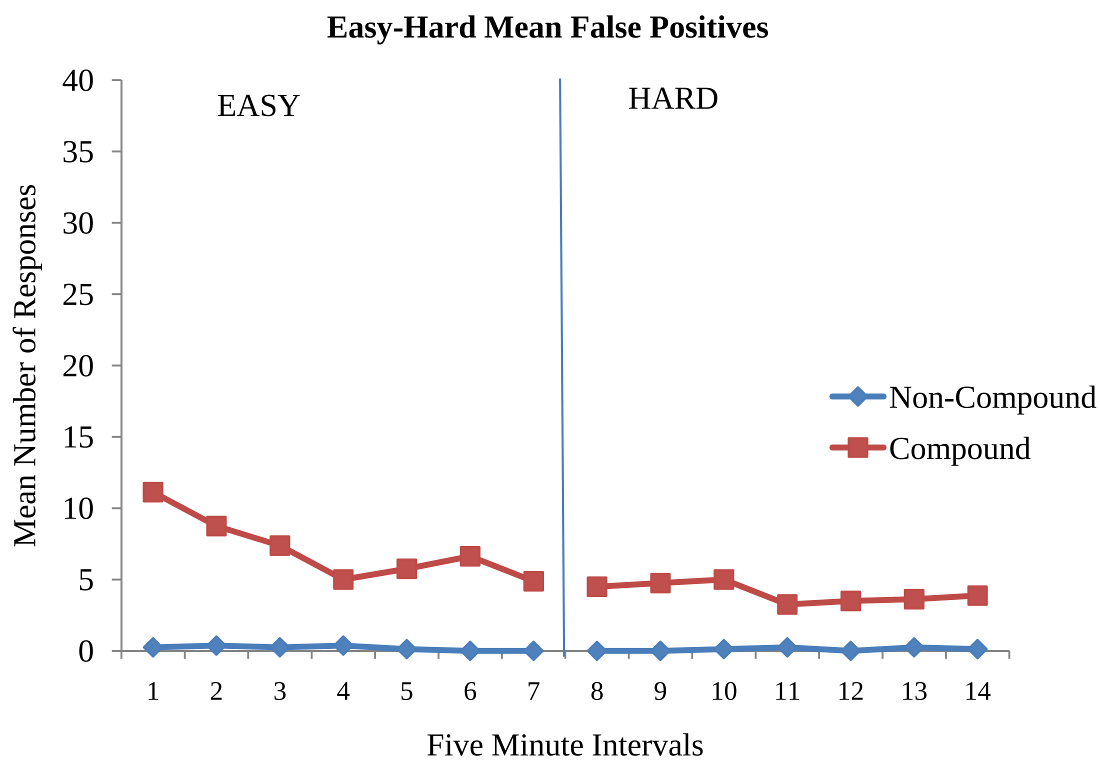

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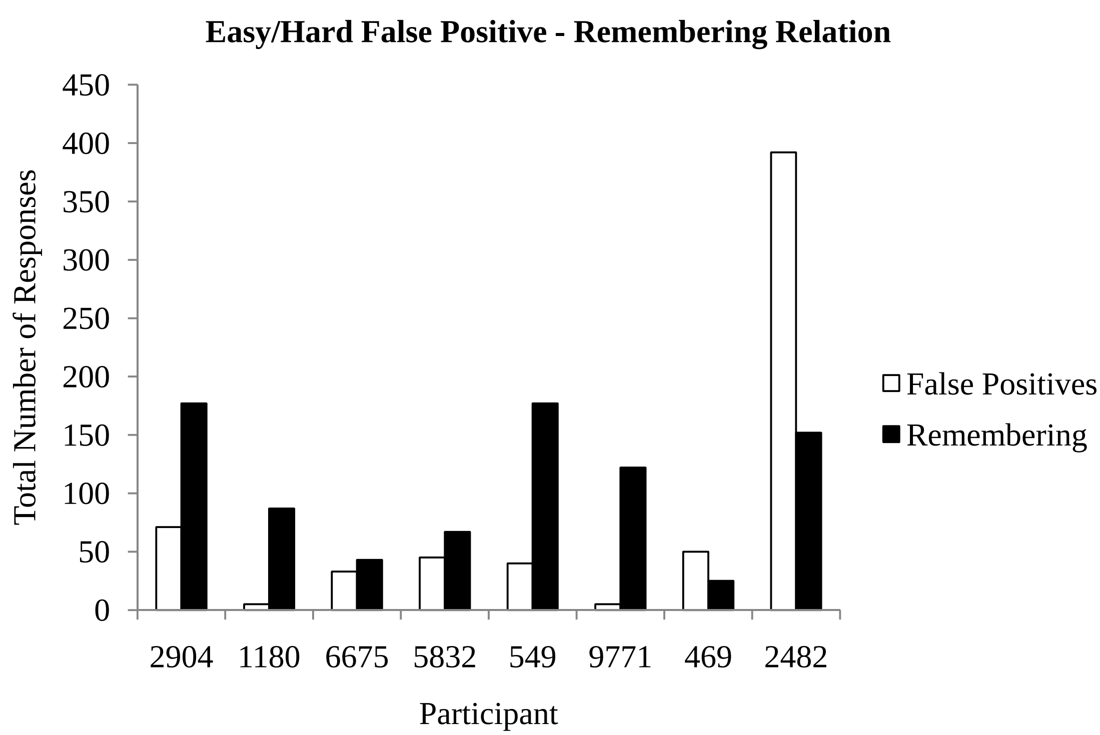

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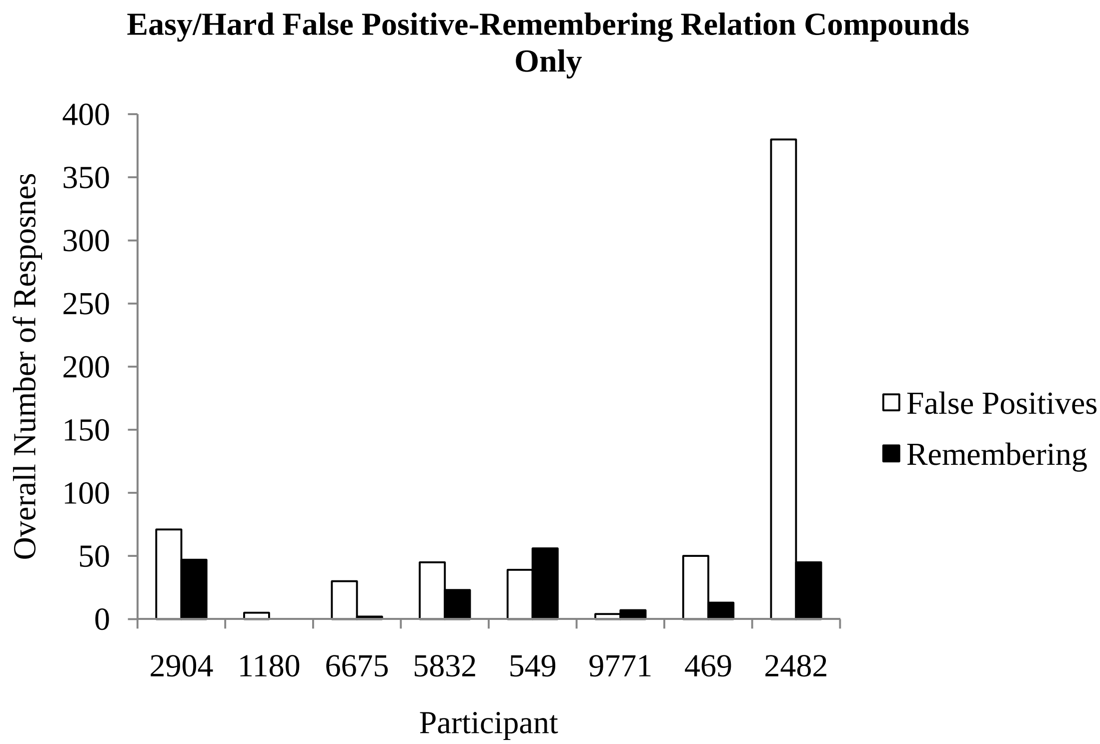

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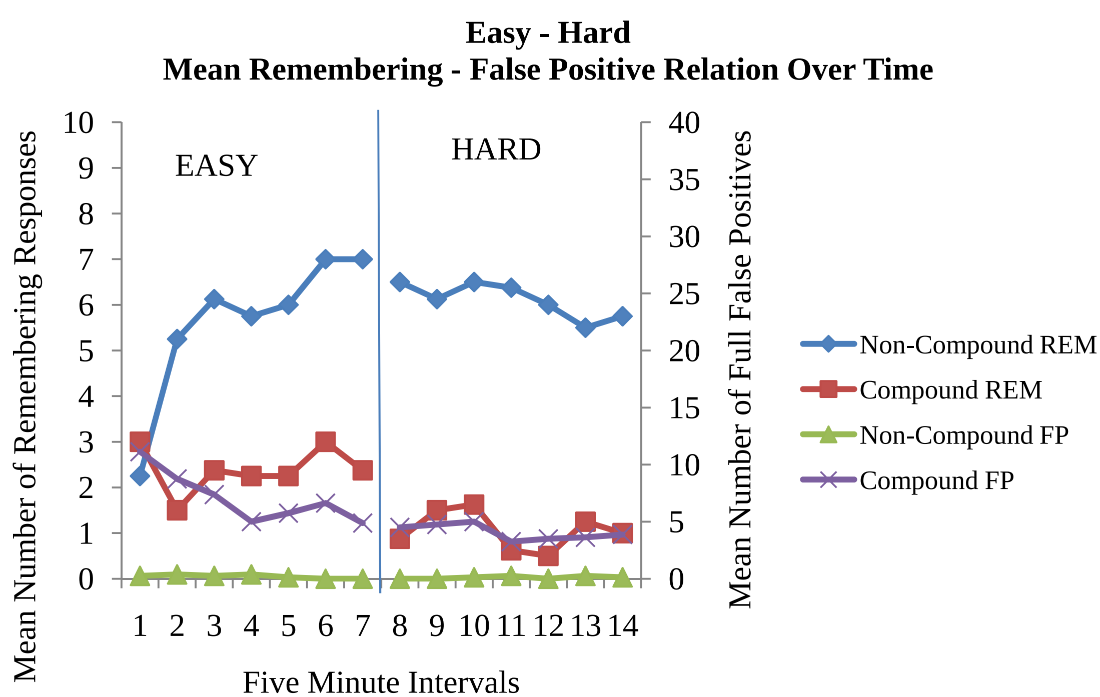

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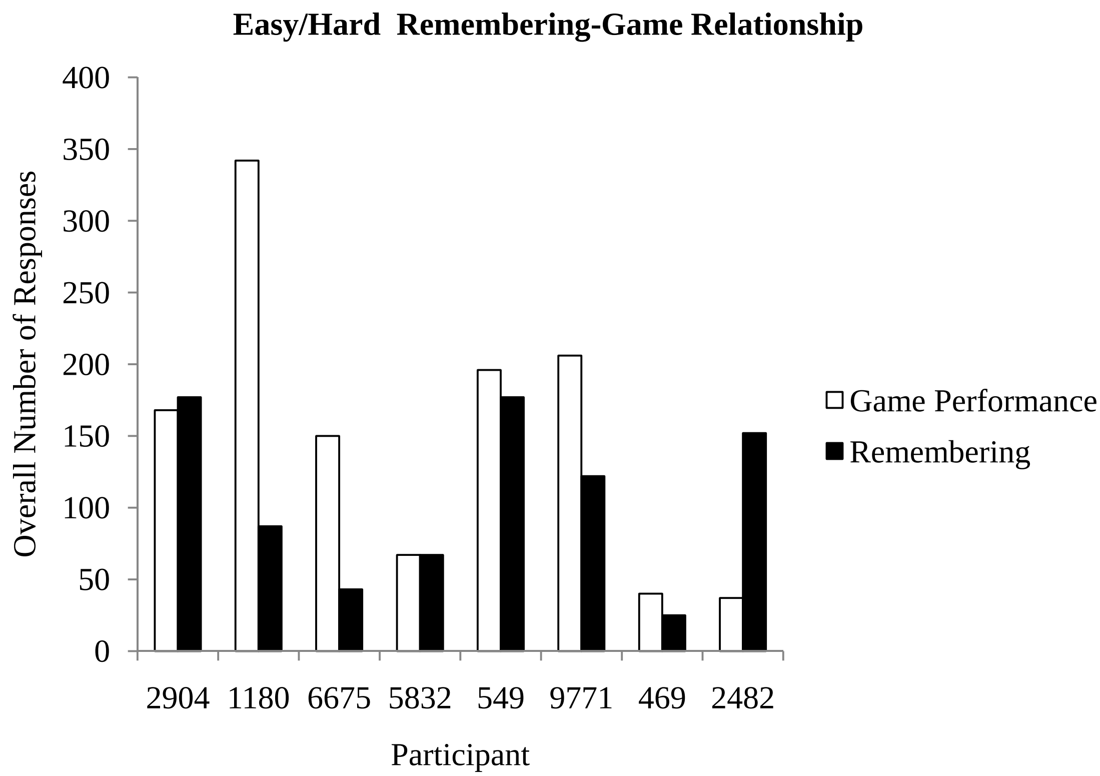

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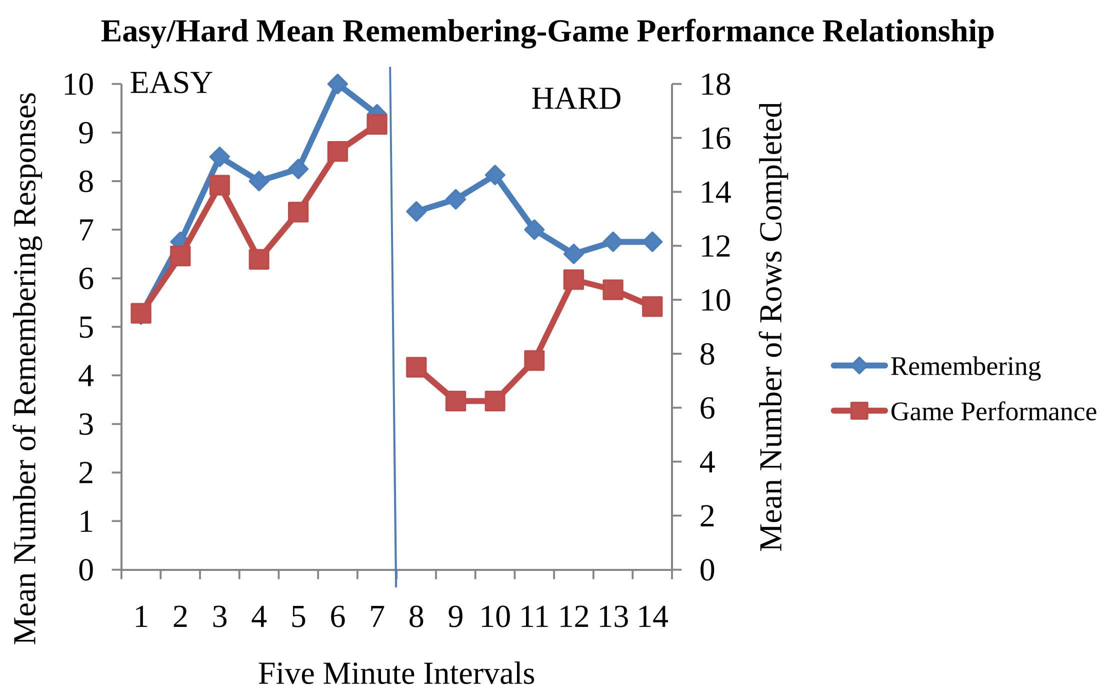

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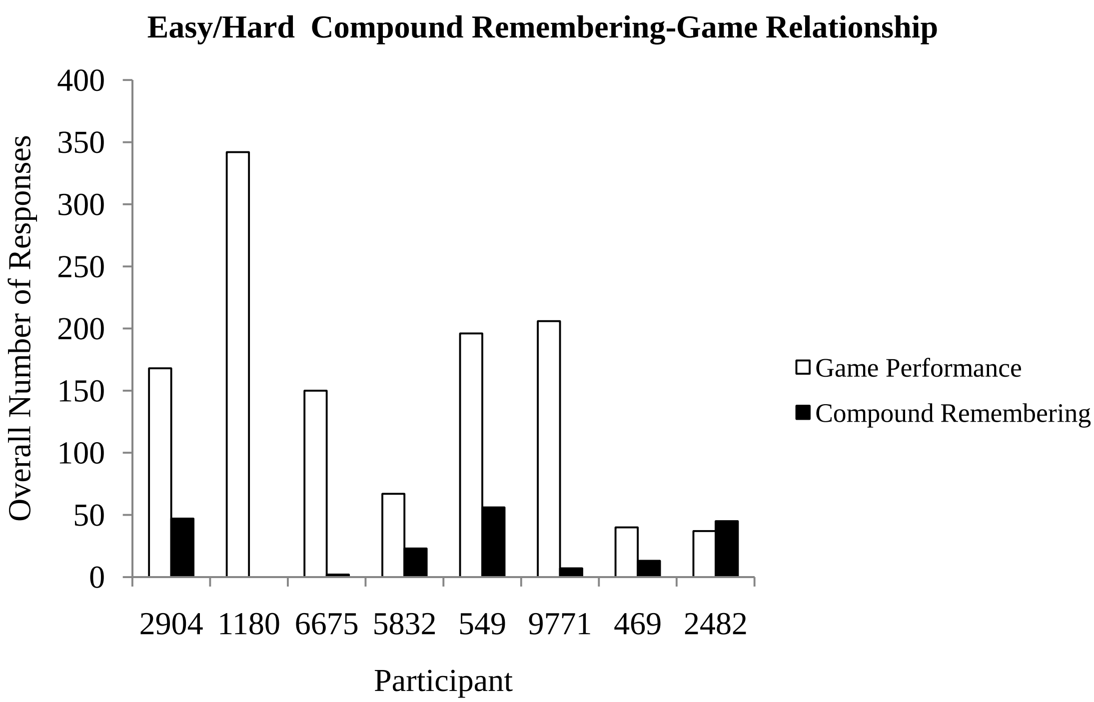

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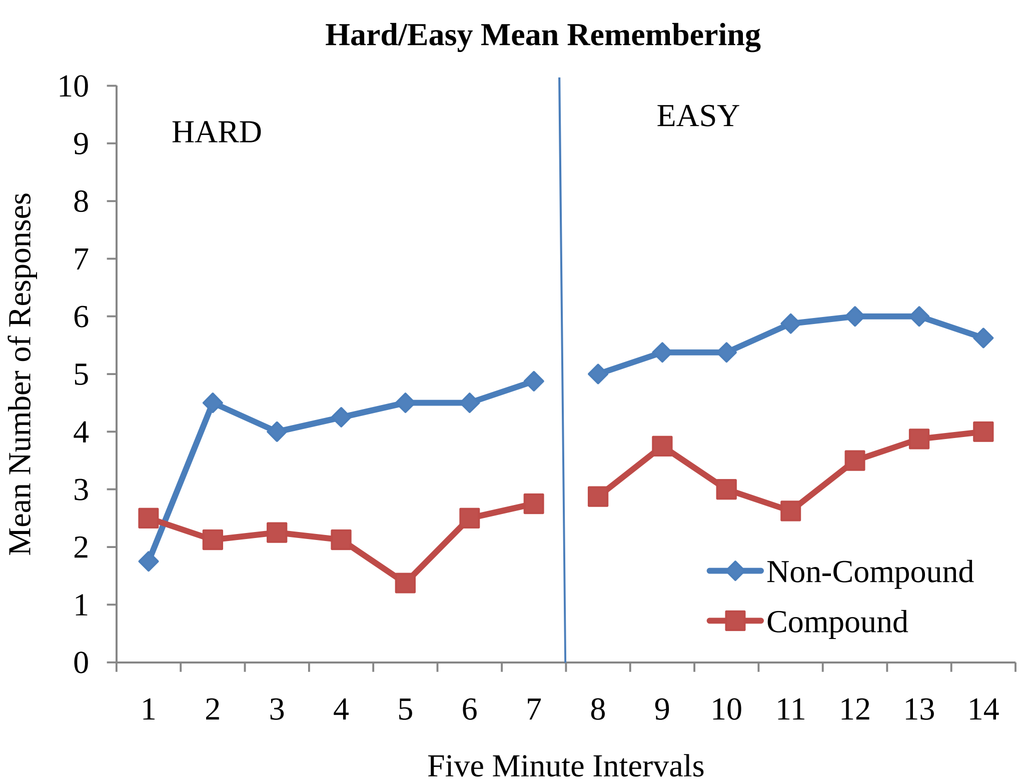

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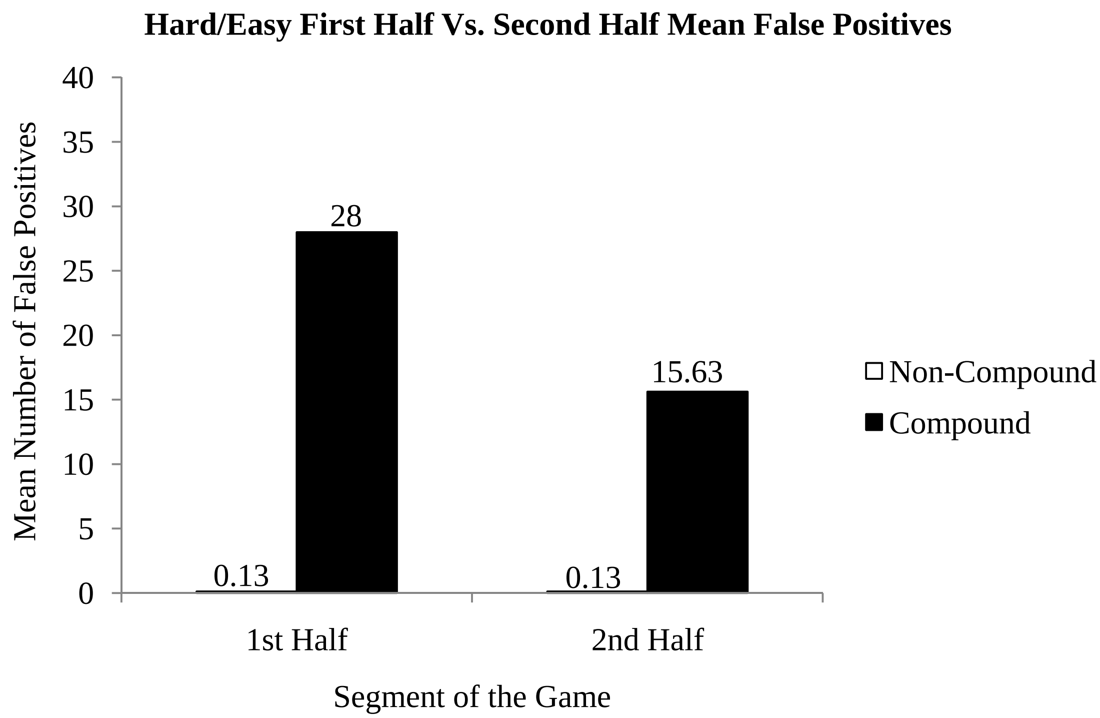

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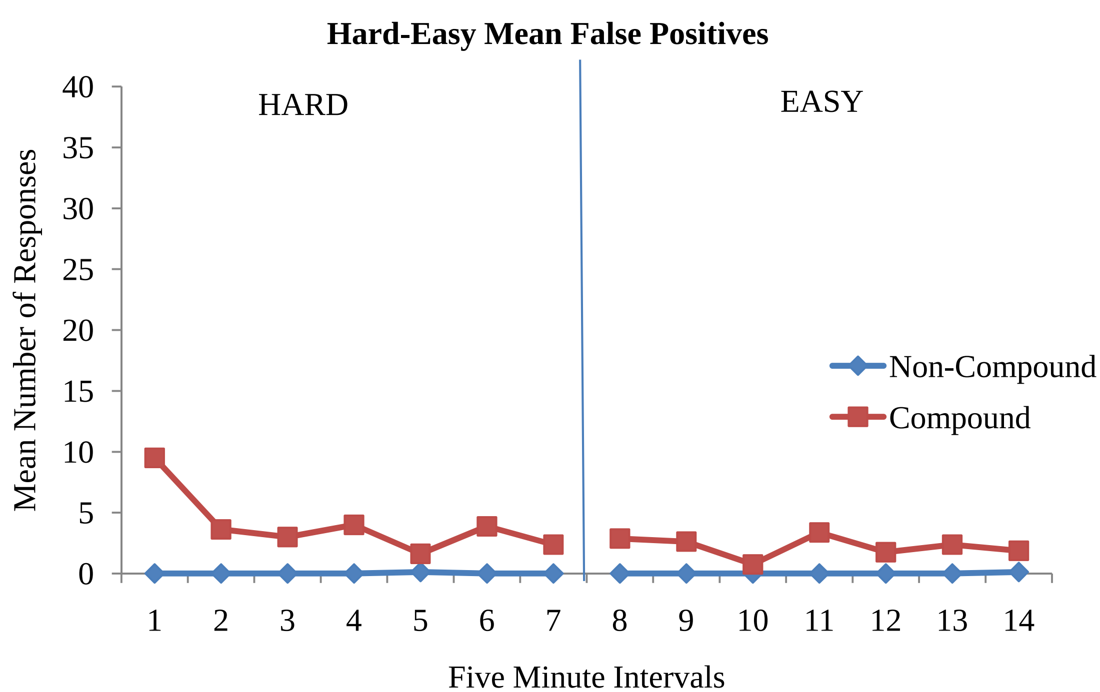

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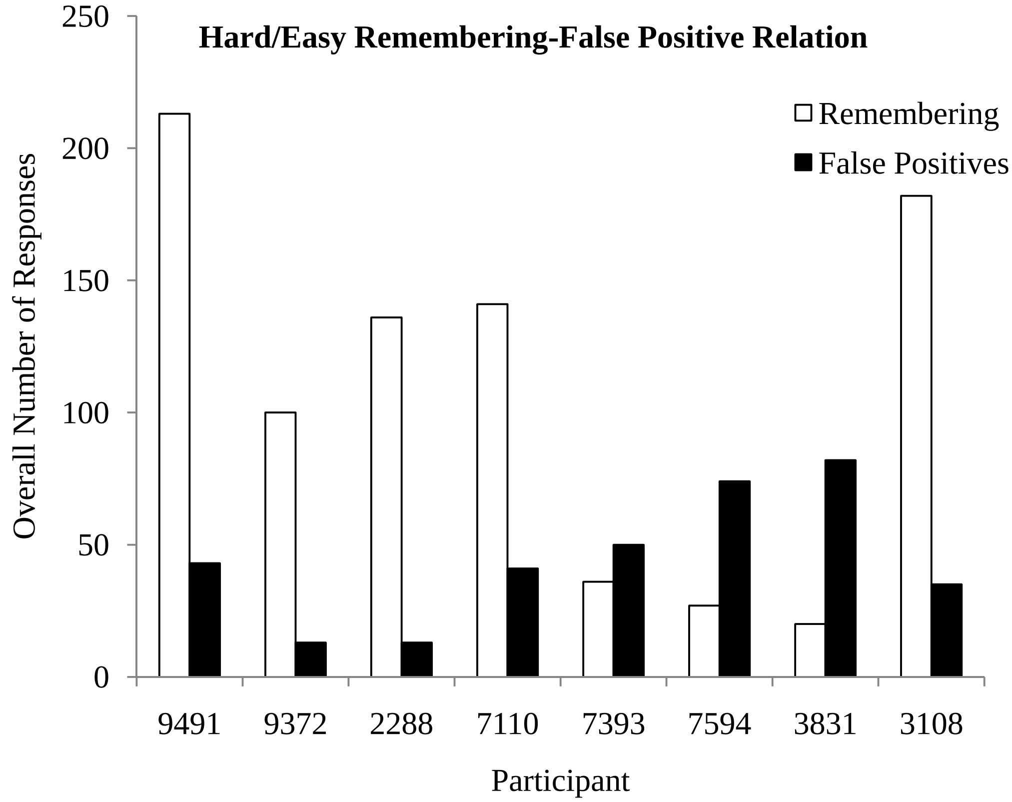

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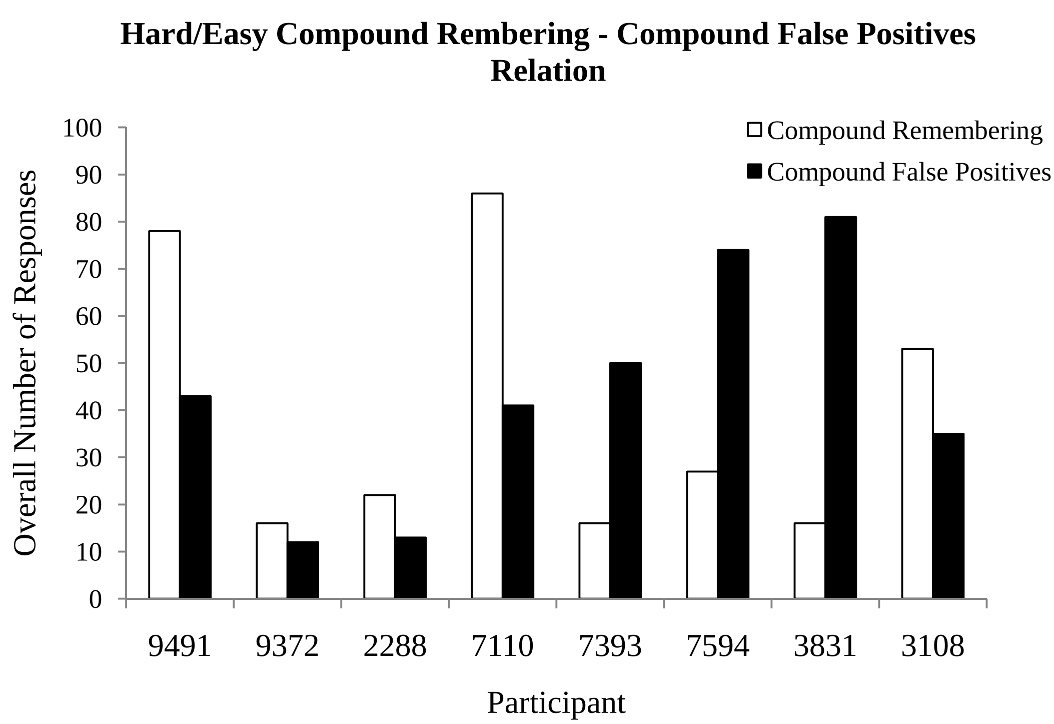

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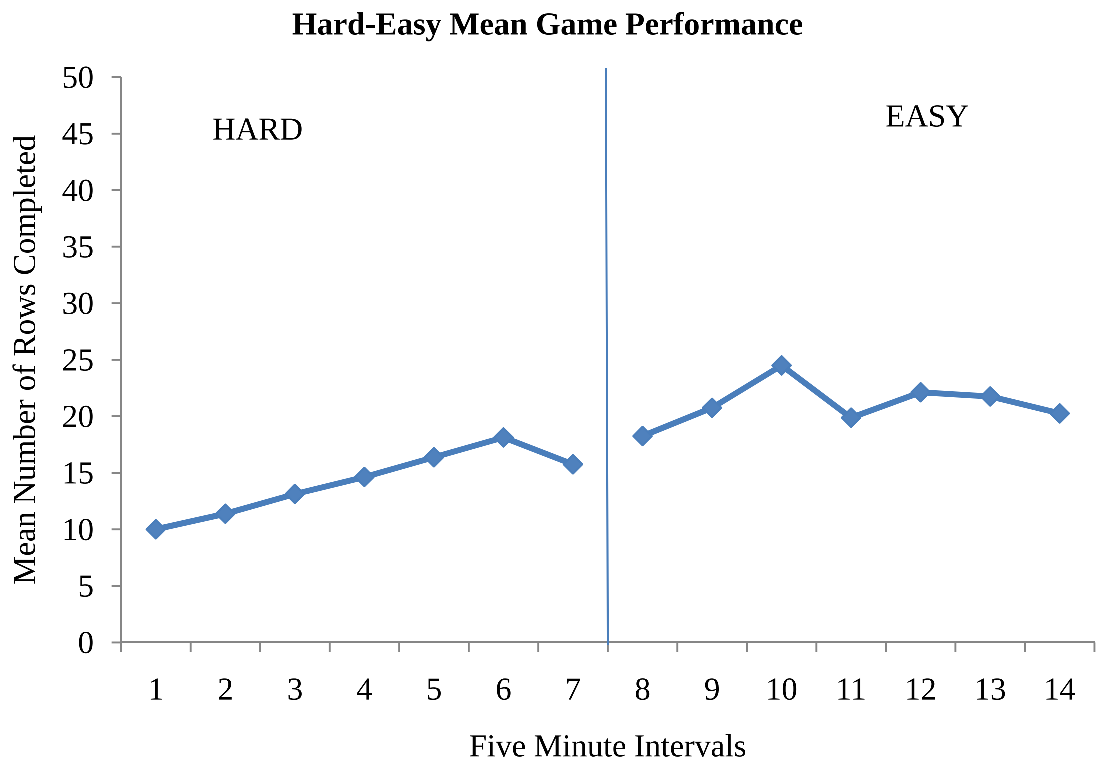

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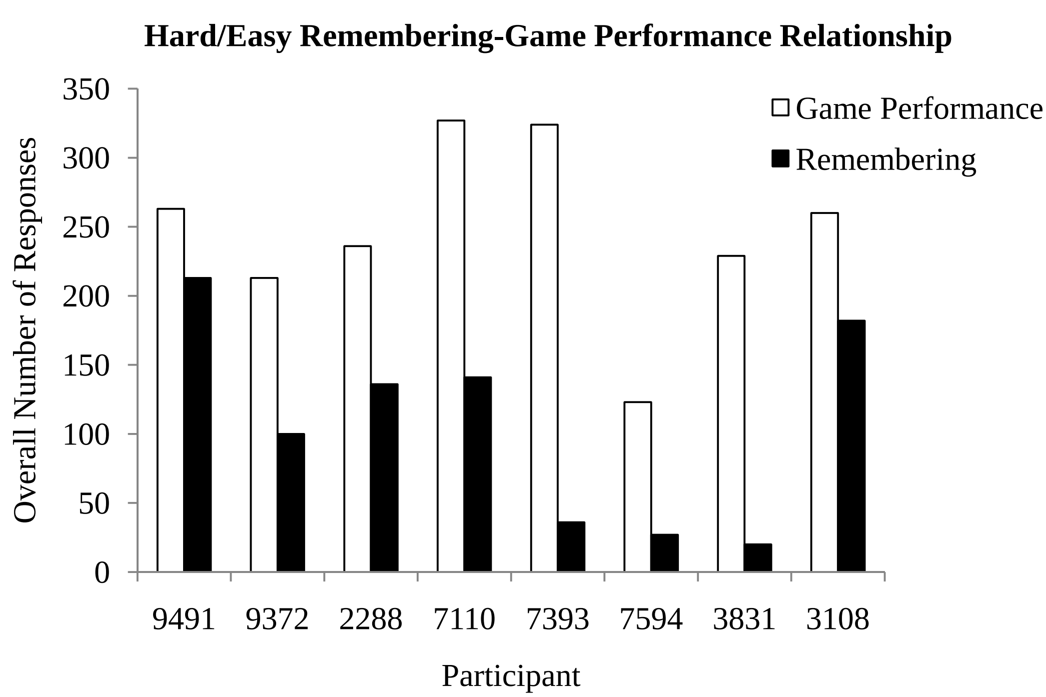

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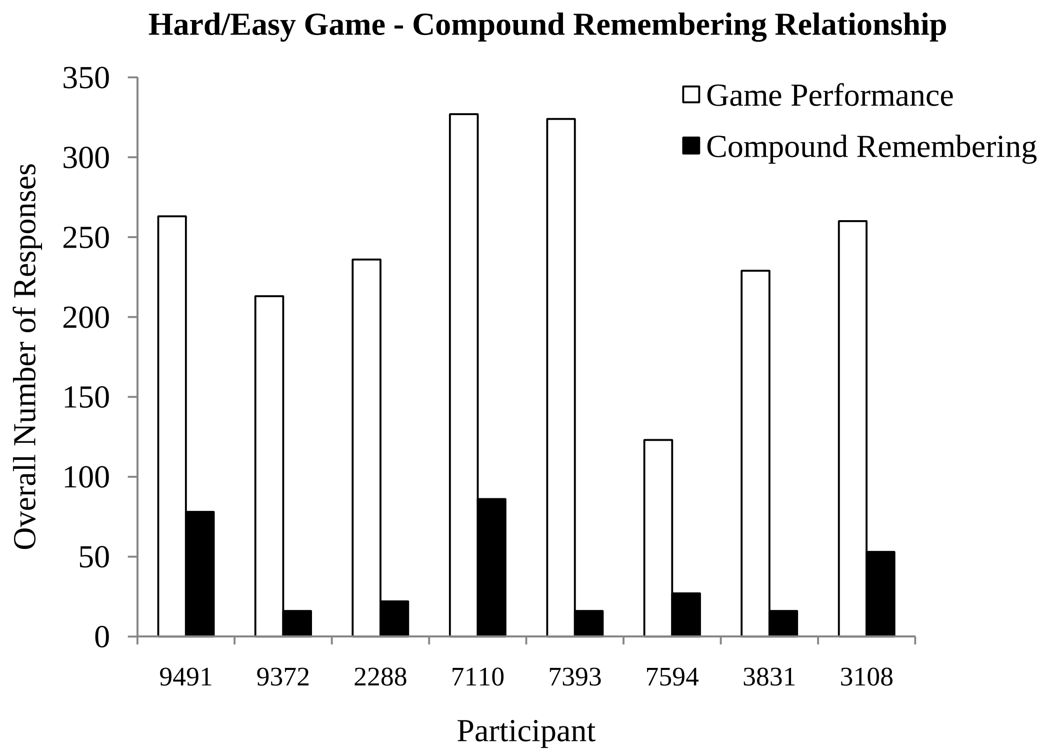

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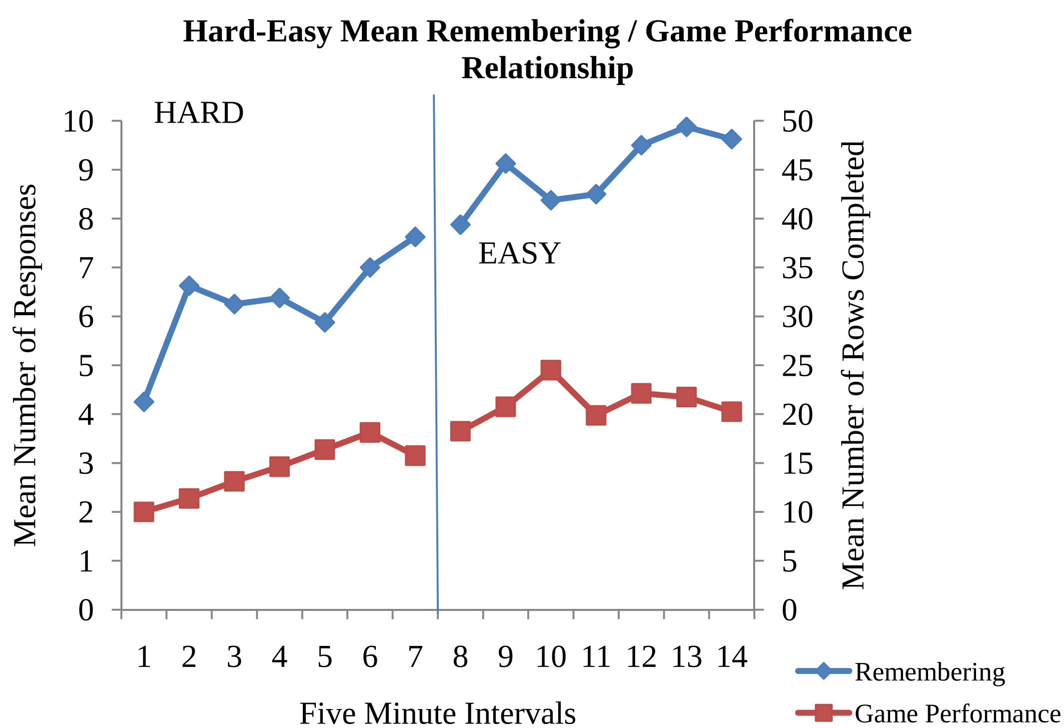

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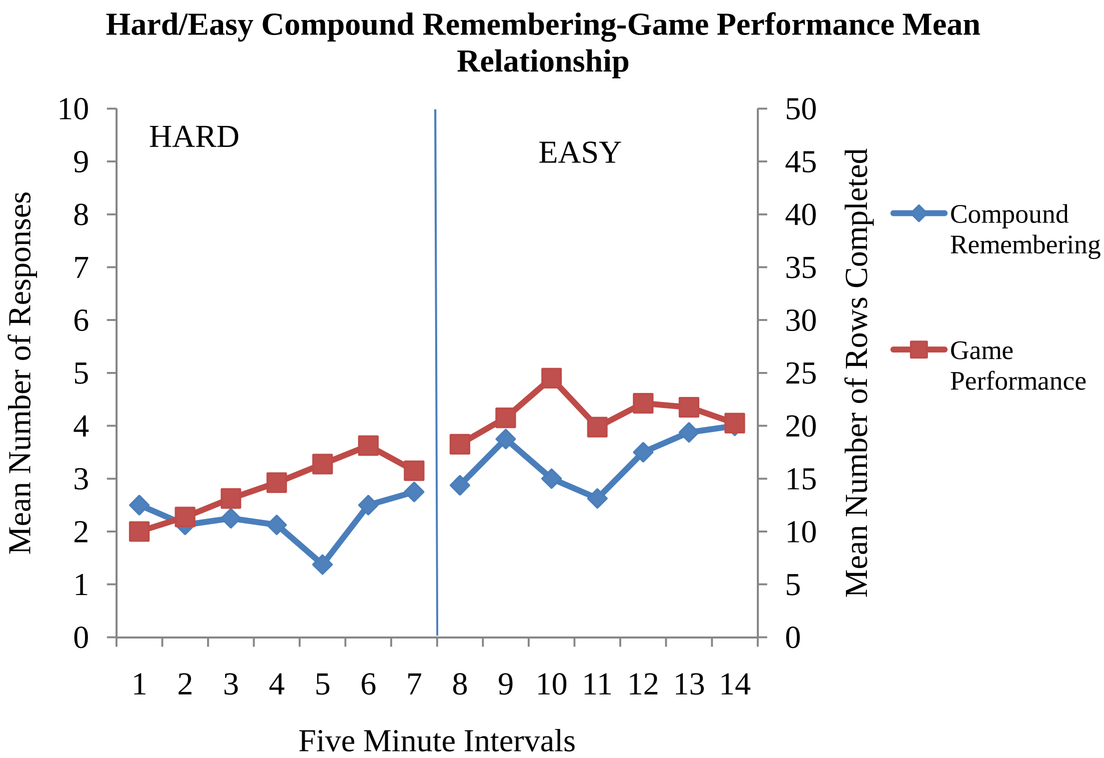

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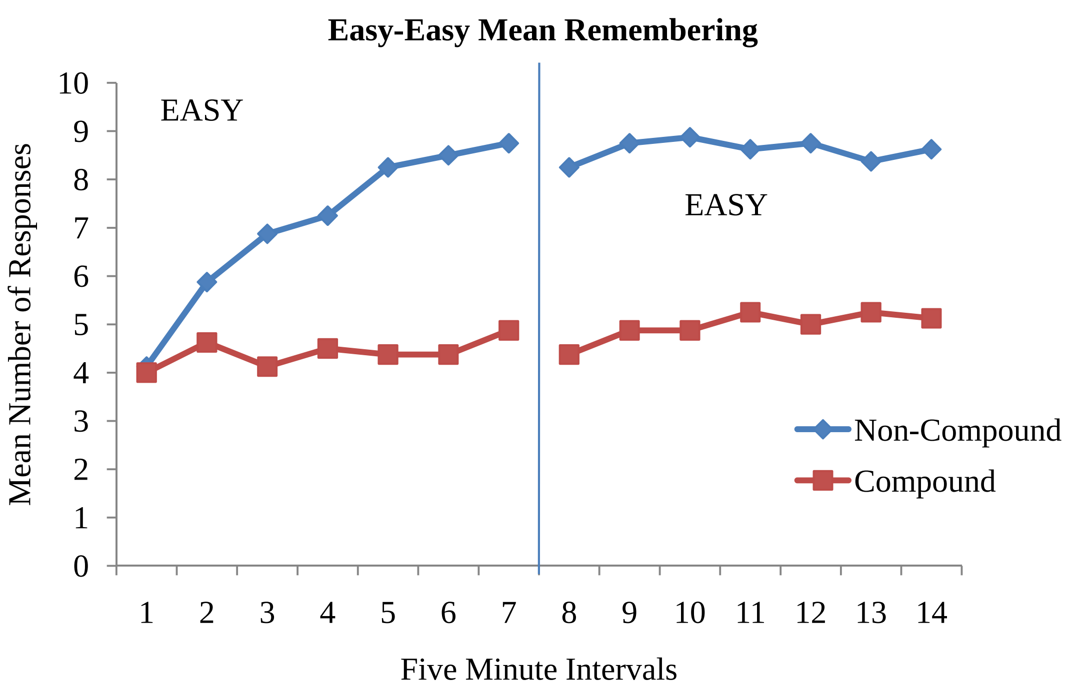

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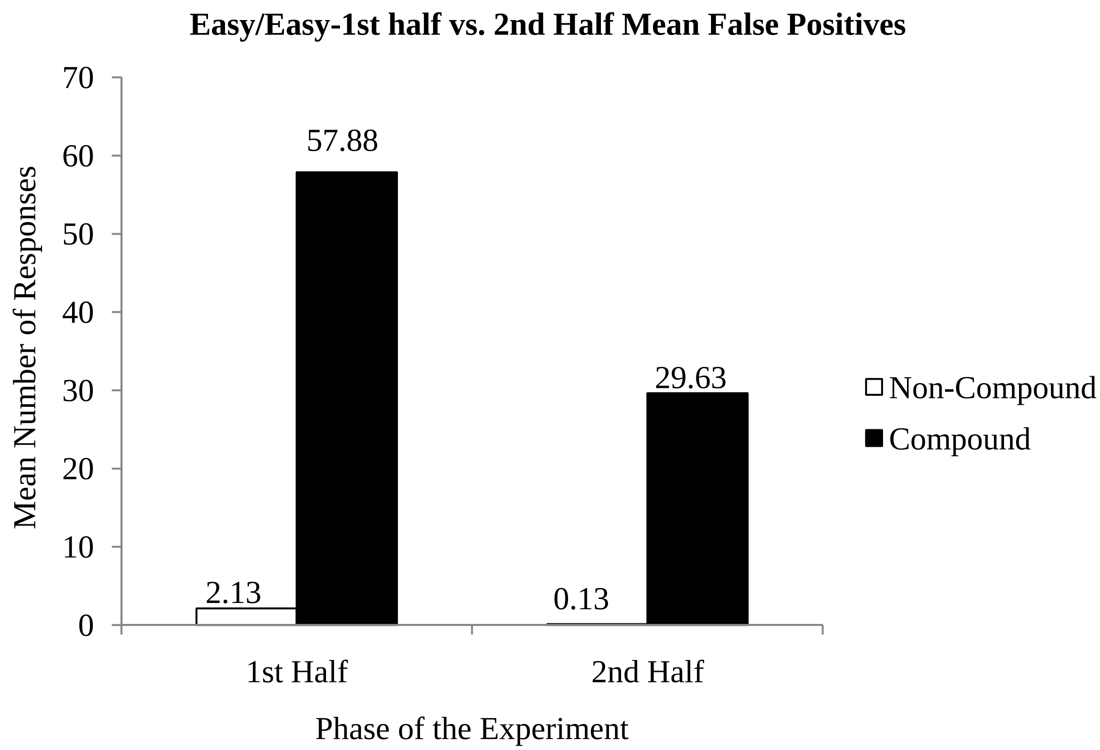

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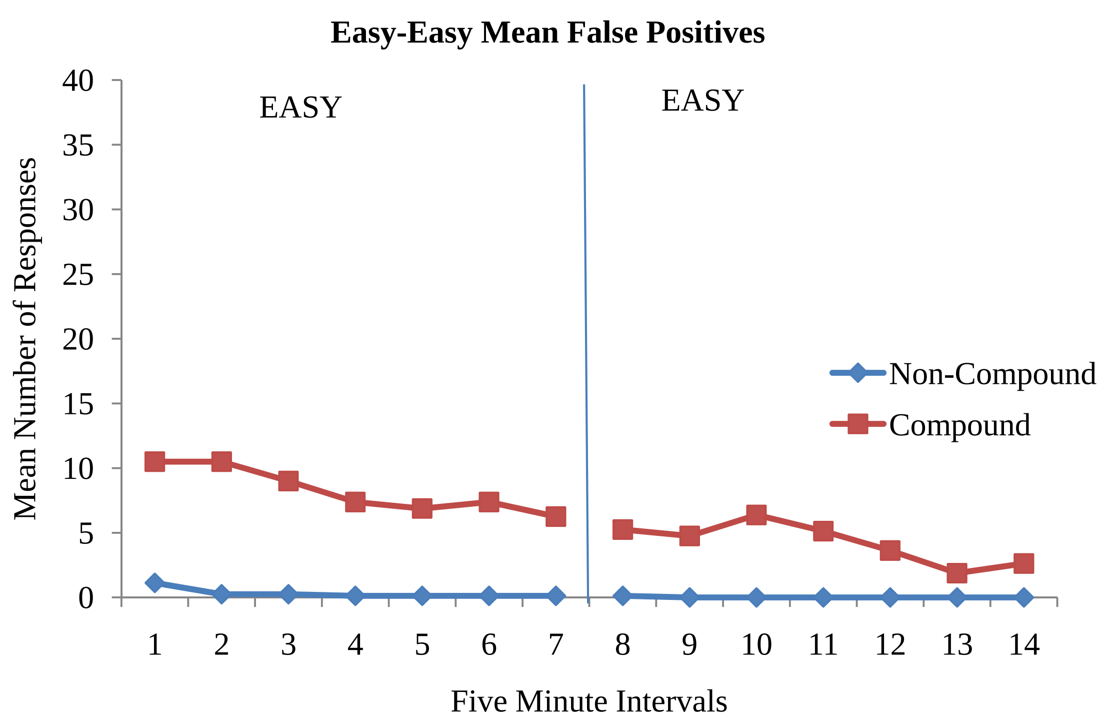

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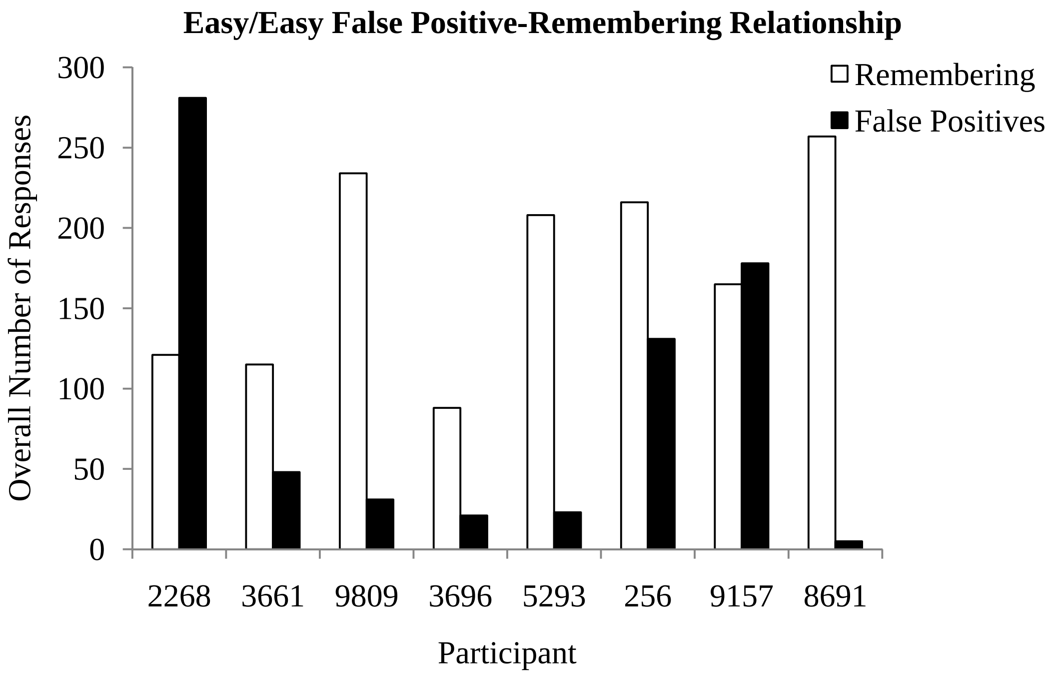

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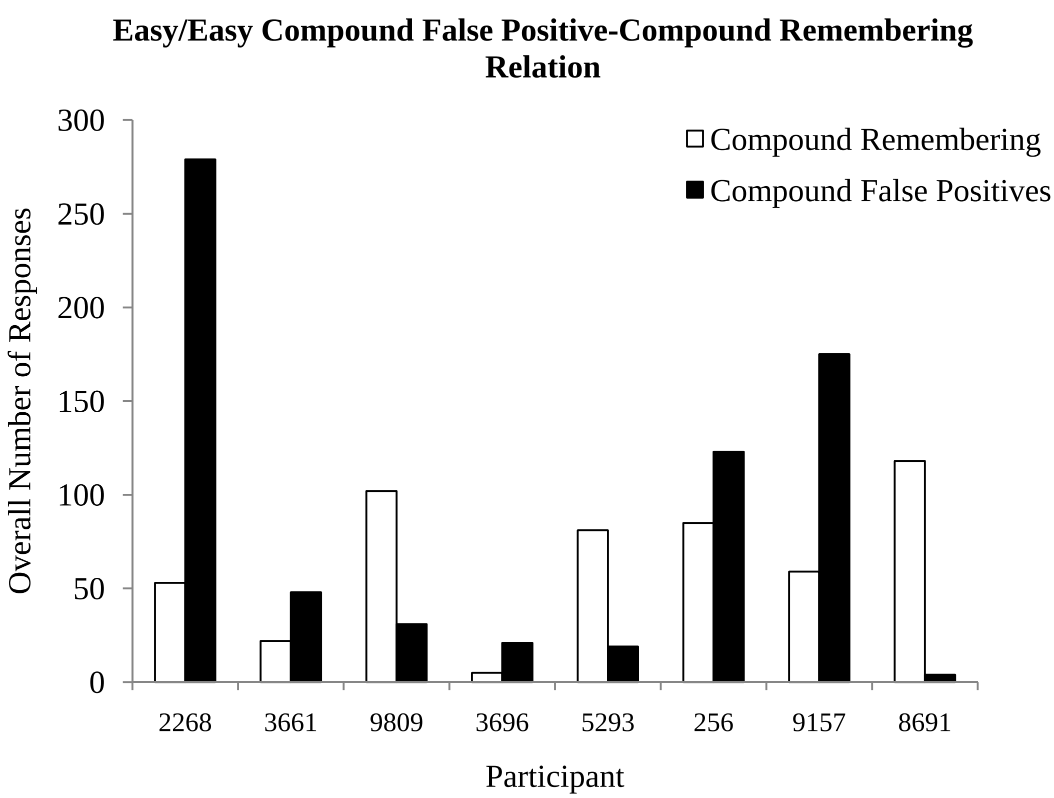

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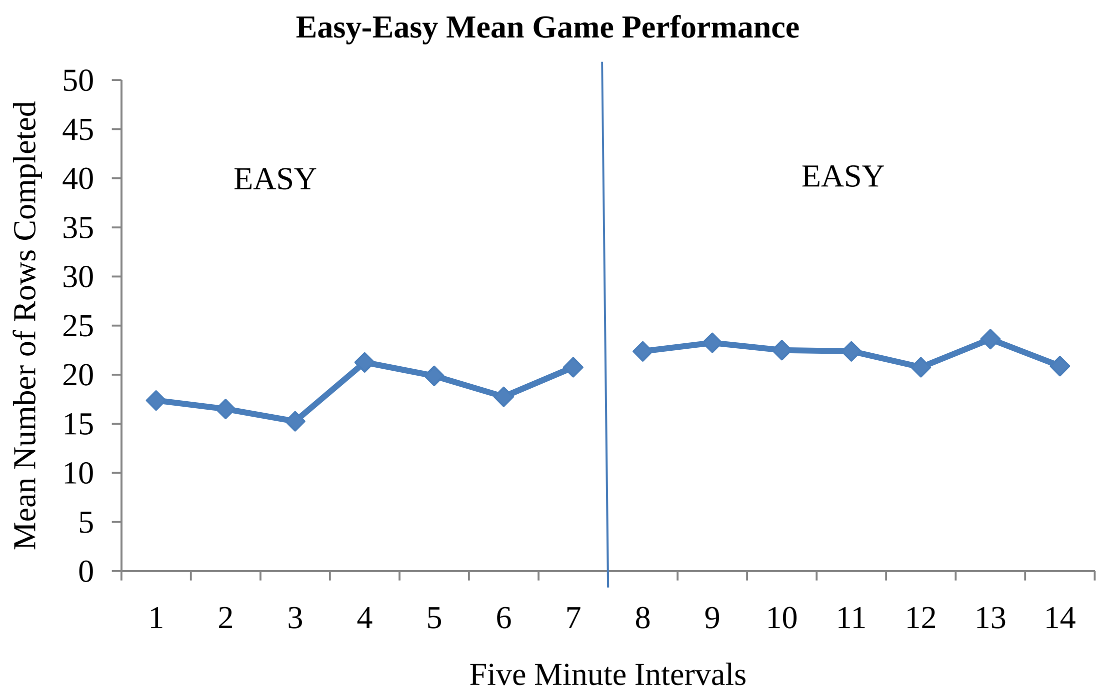

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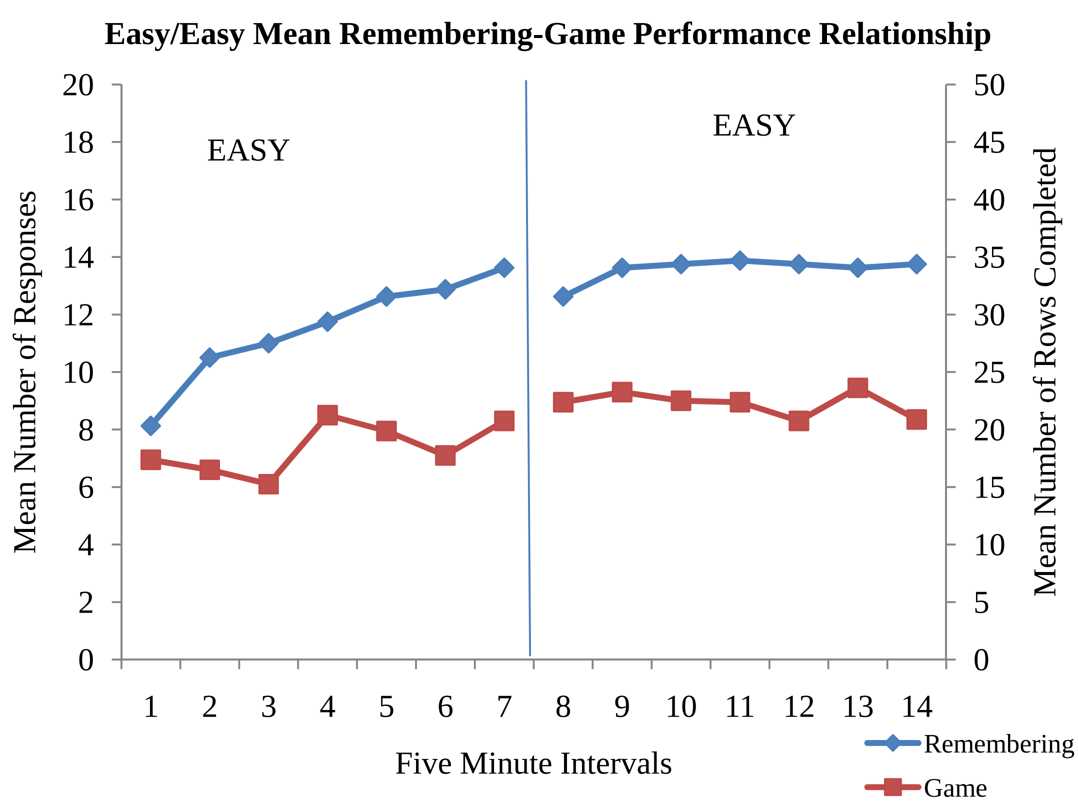

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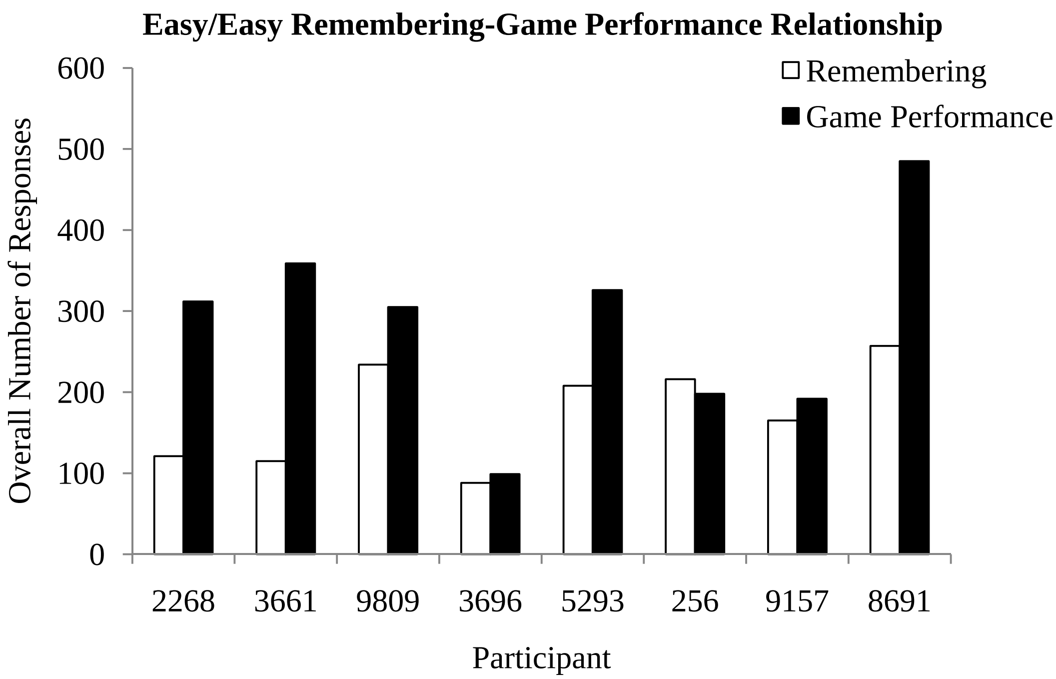

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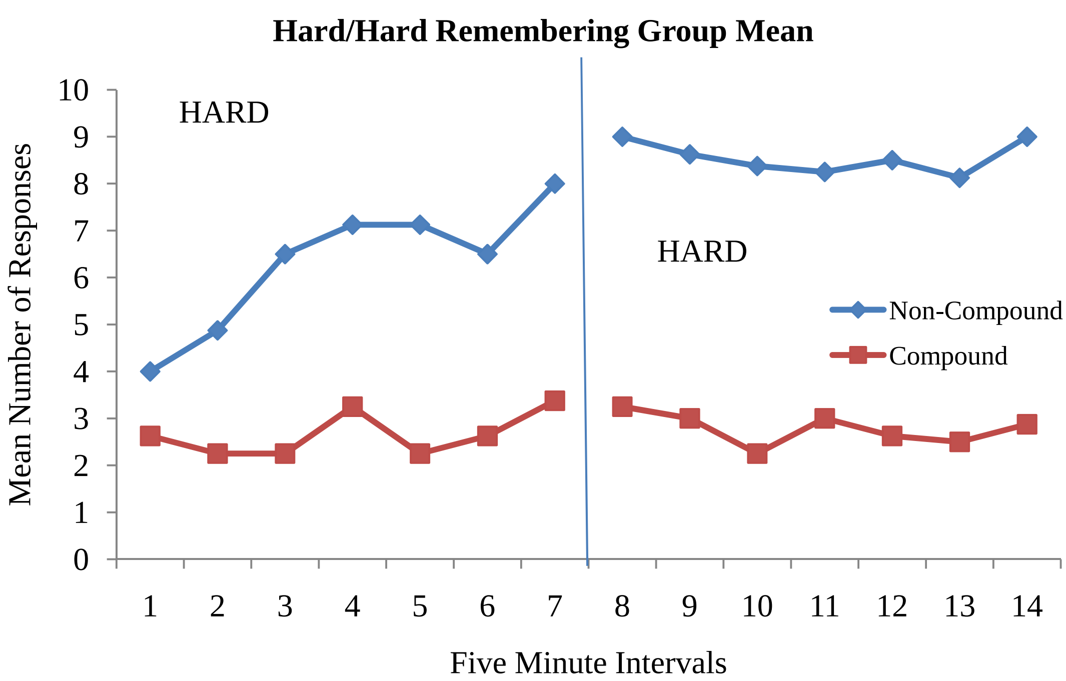

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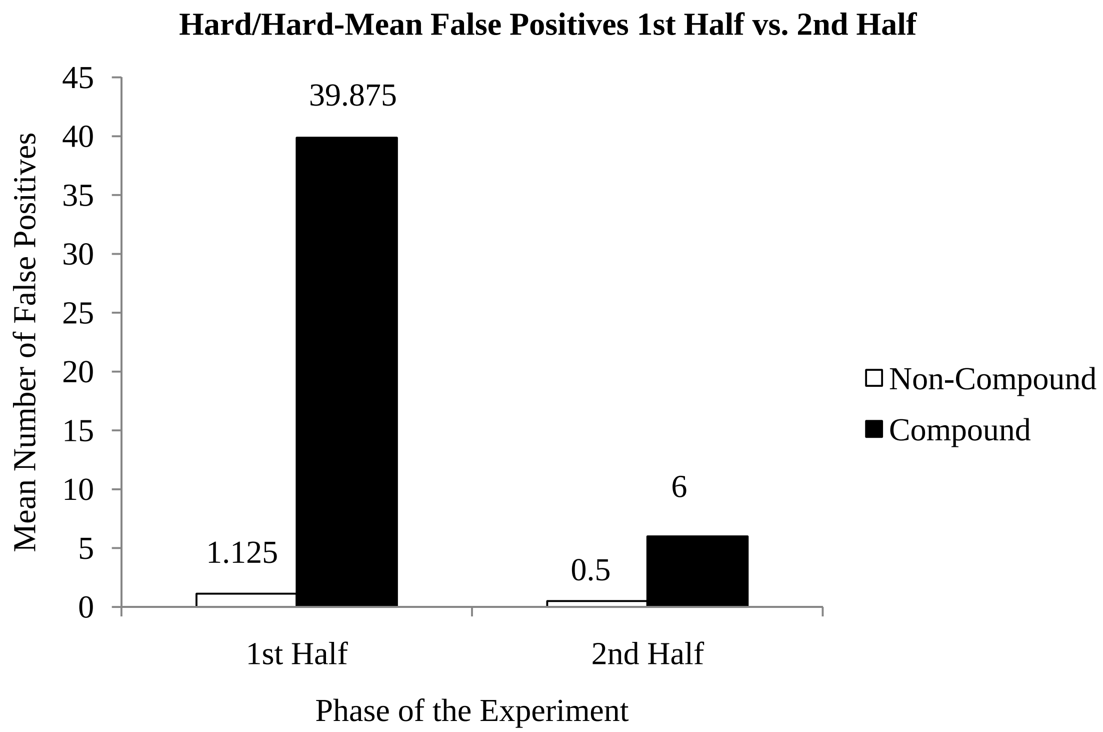

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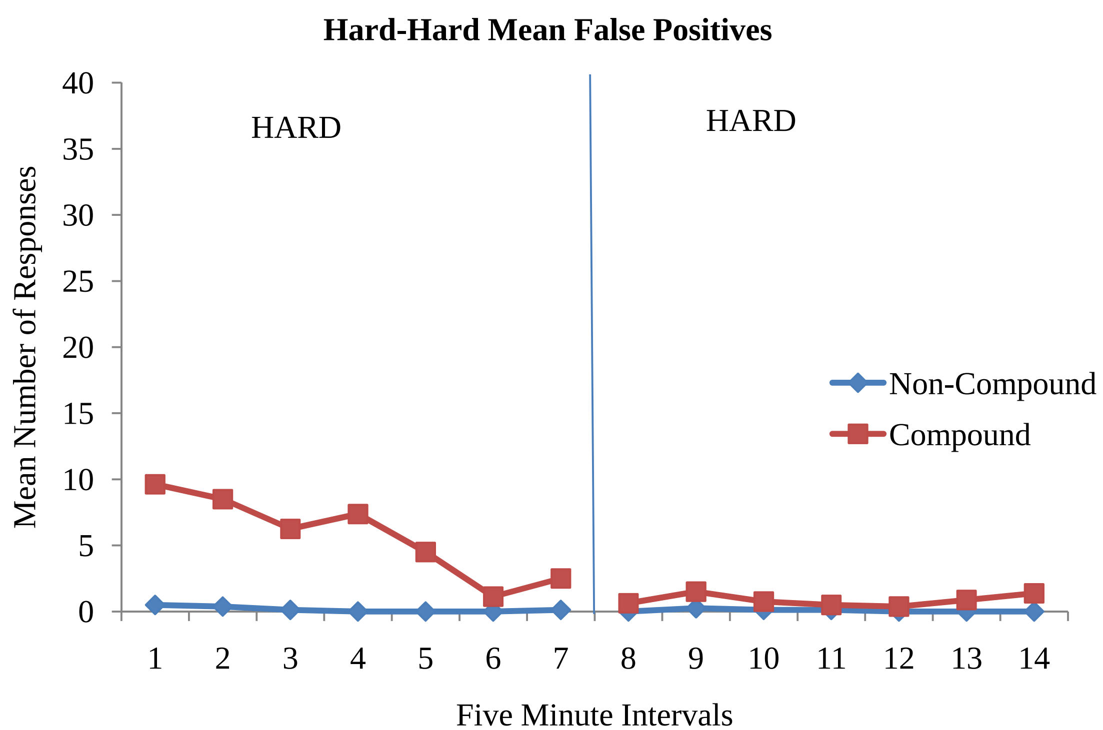

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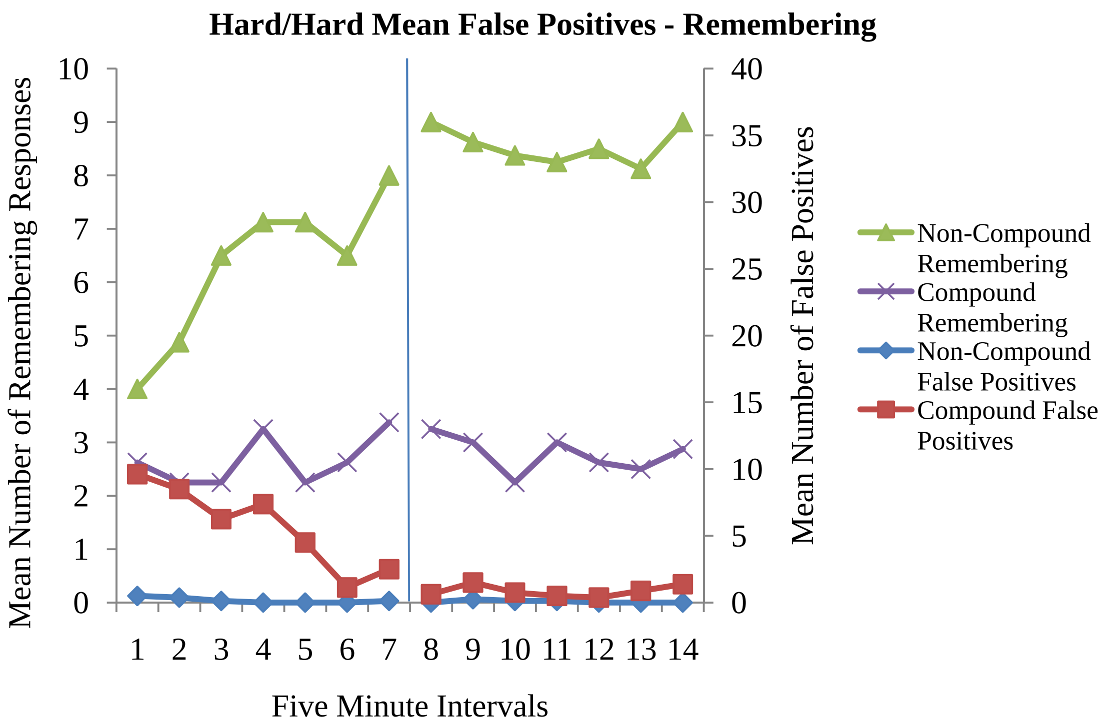

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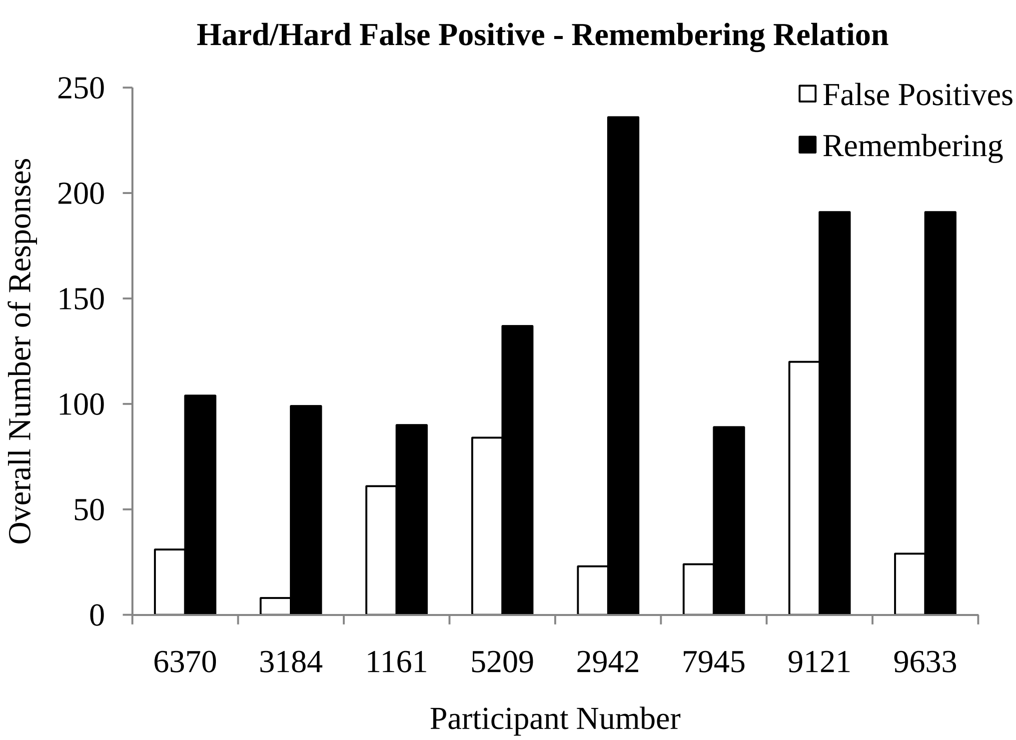

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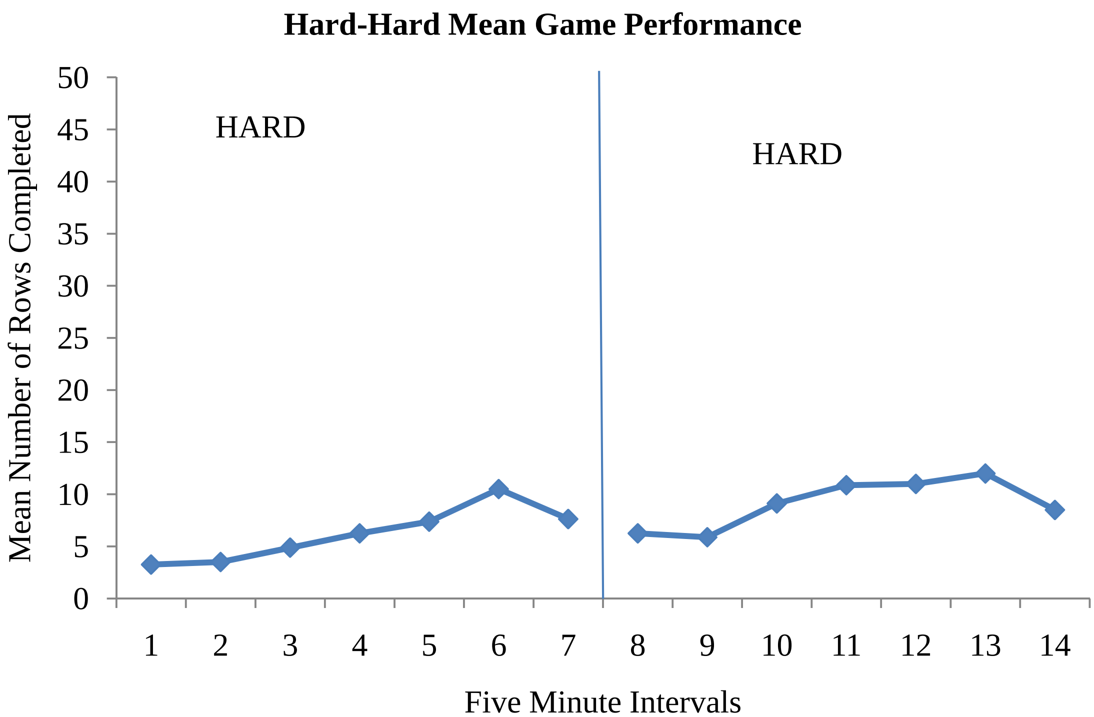

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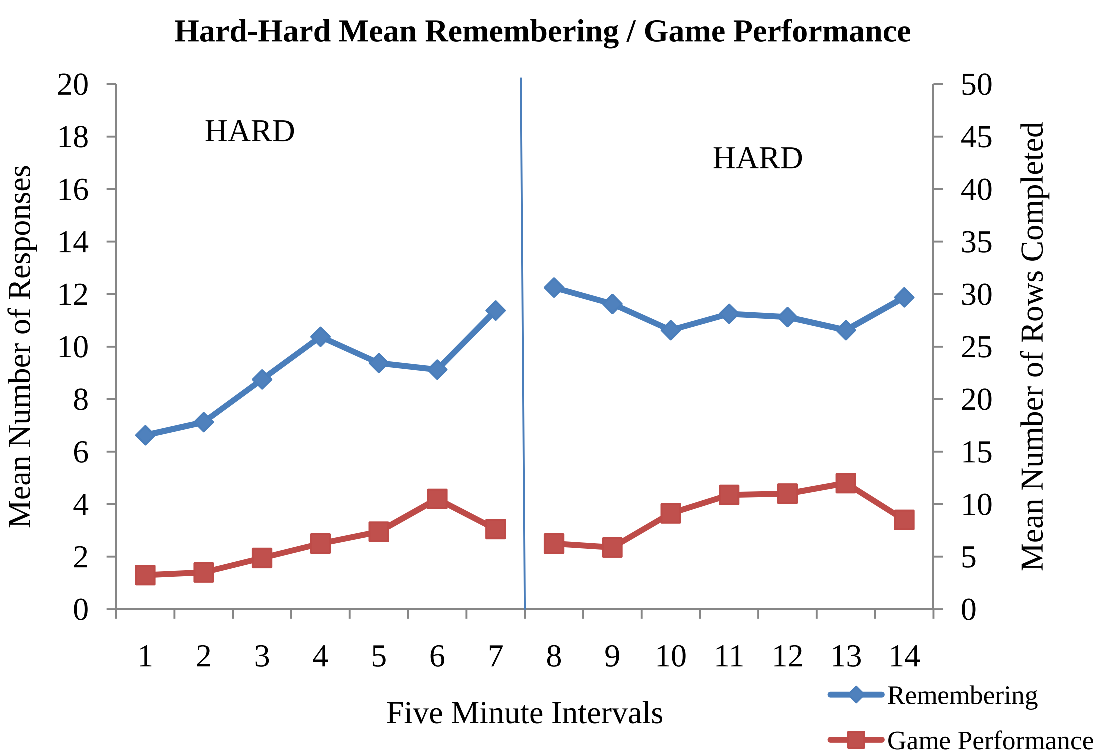

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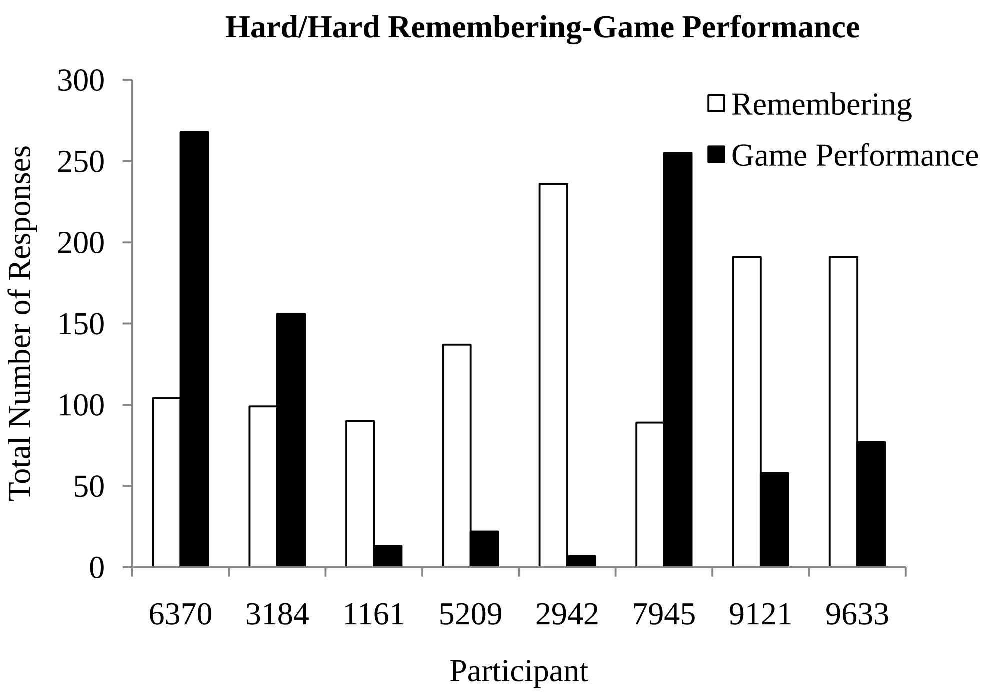
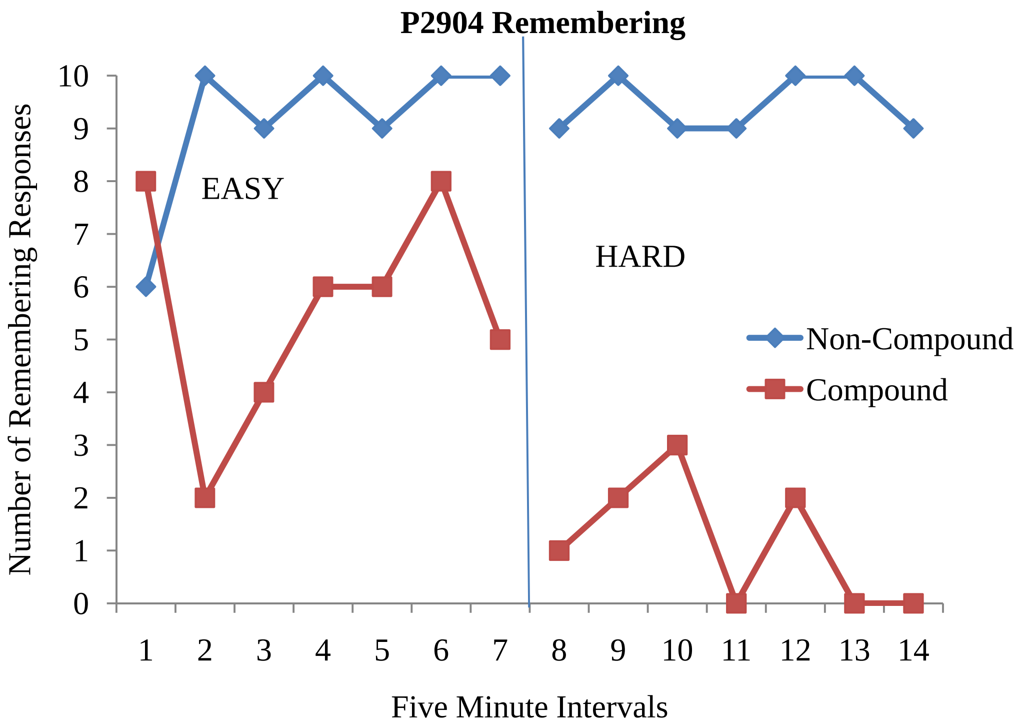
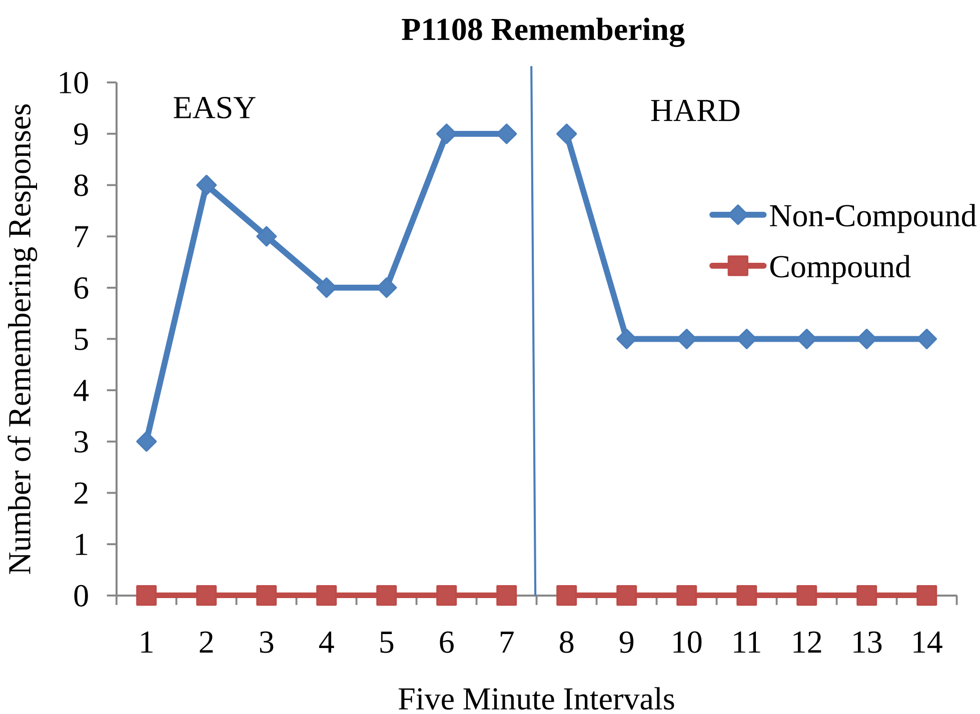
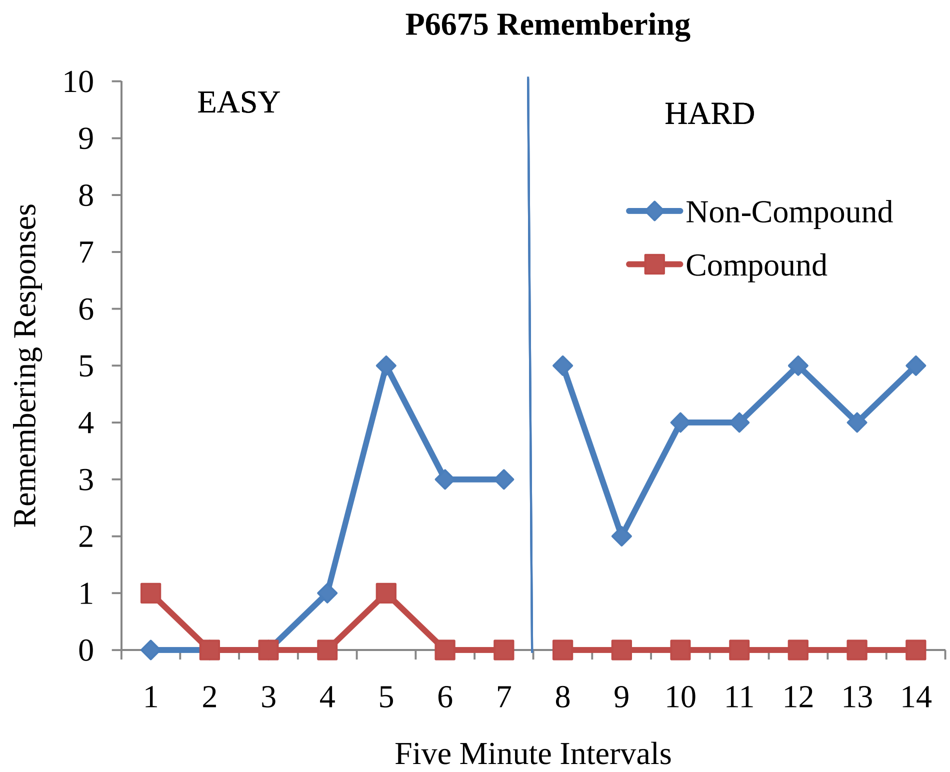
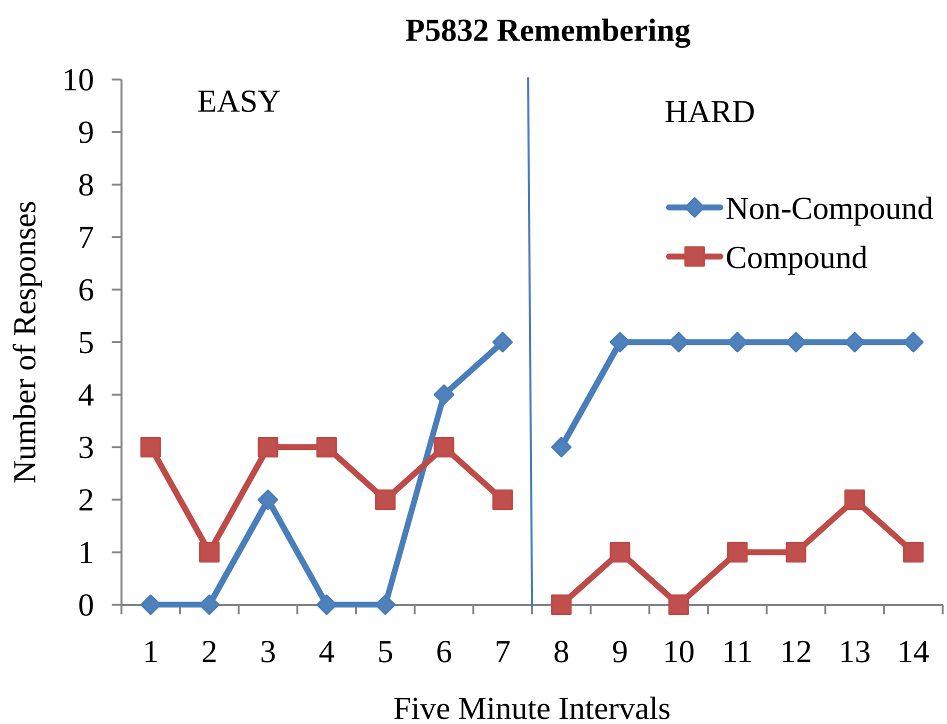

Hard/Hard Remembering-Game Performance
Total Number of Responses
300
250
200
150
100
50
0
Remembering
Game Performance
6370
3184
1161
5209
2942
7945
9121
9633
Participant

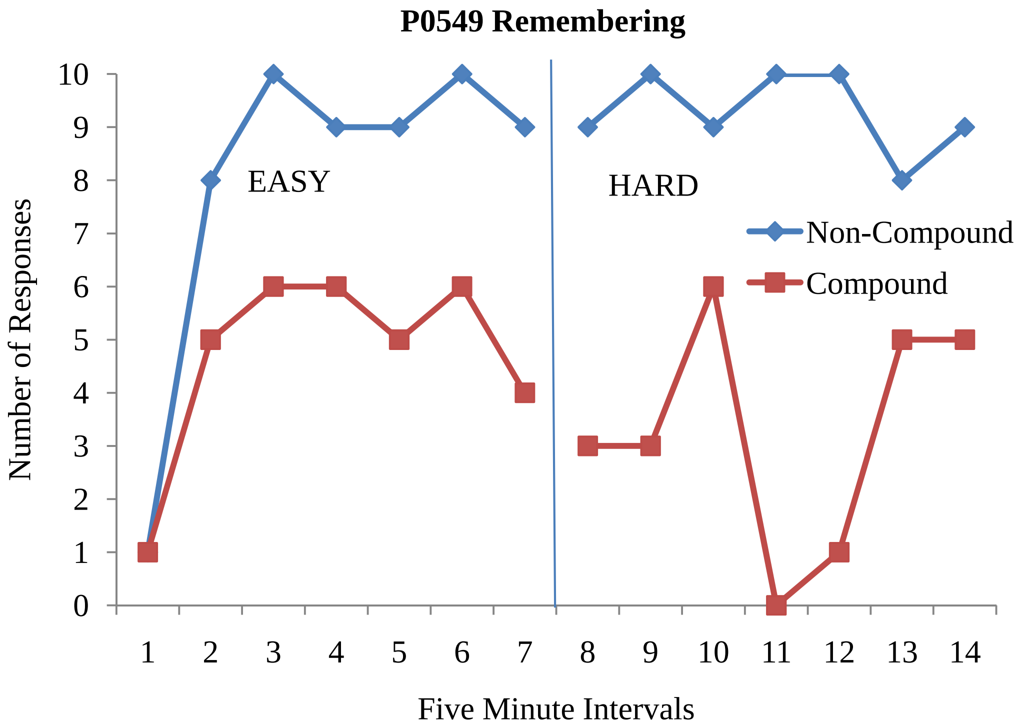
APPENDIX A1
EASY-HARD INDIVIDUAL REMEMBERING DATA

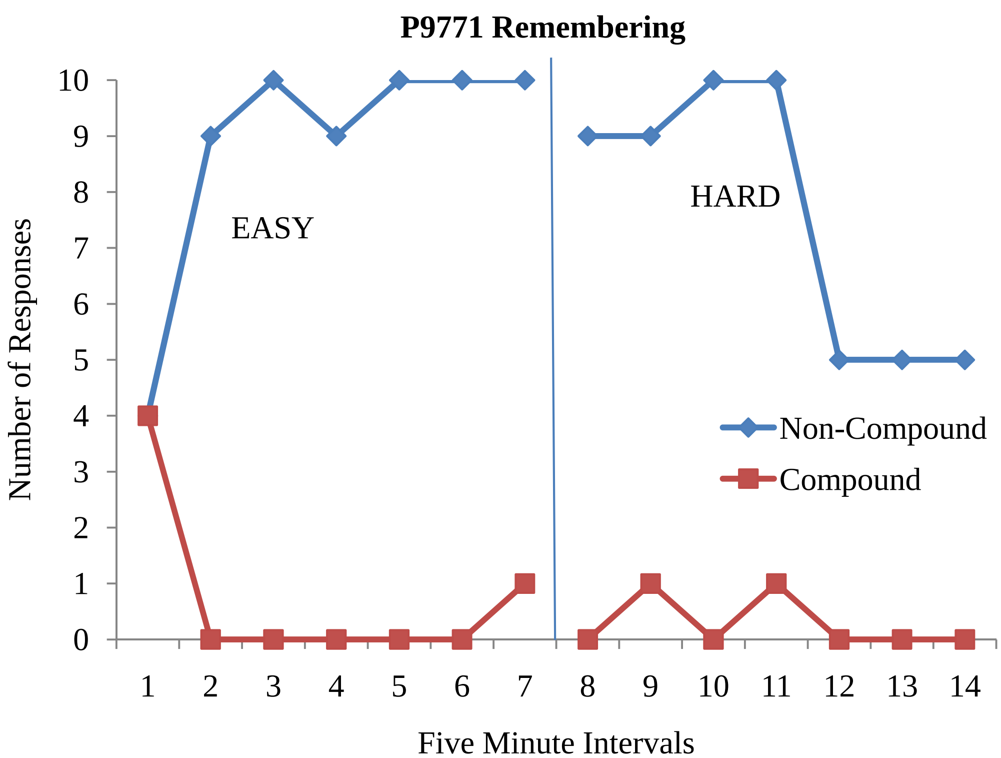


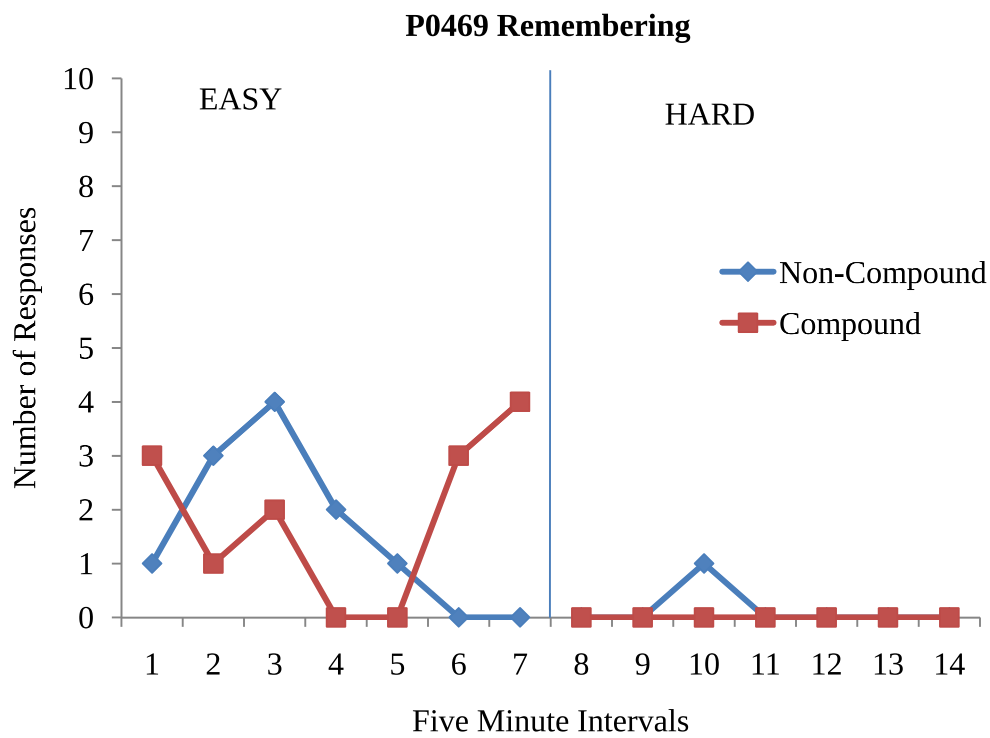


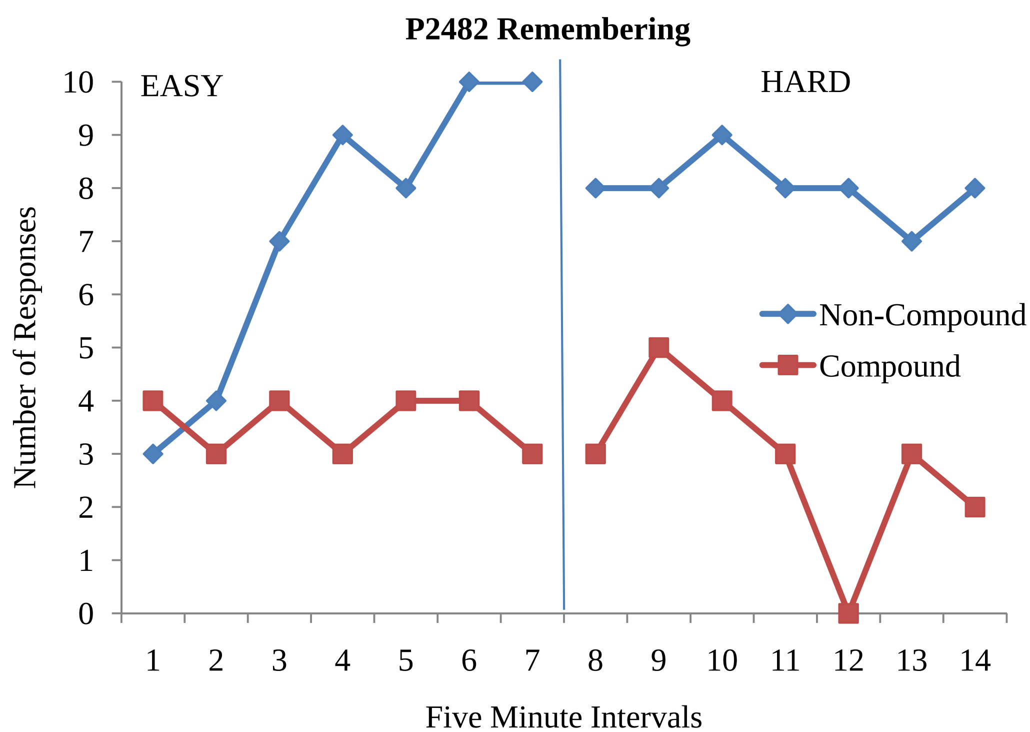

P6675 Remembering
Remembering Responses
0
1
2
3
4
5
6
7
8
9
10
EASY
HARD
Non-Compound
Compound
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Five Minute Intervals


P5832 Remembering
Number of Responses
0
1
2
3
4
5
6
7
8
9
10
EASY
HARD
Non-Compound
Compound
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Five Minute Intervals

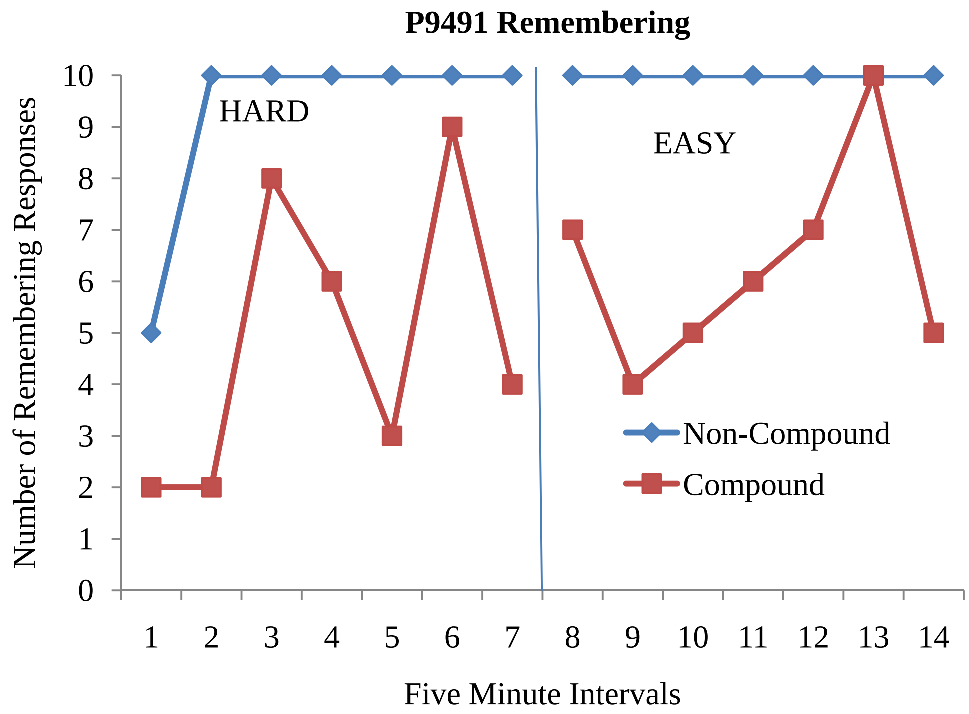

P0549 Remembering
Number of Responses
10
9
8
7
6
5
4
3
2
1
0
EASY
HARD
Non-Compound
Compound
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Five Minute Intervals

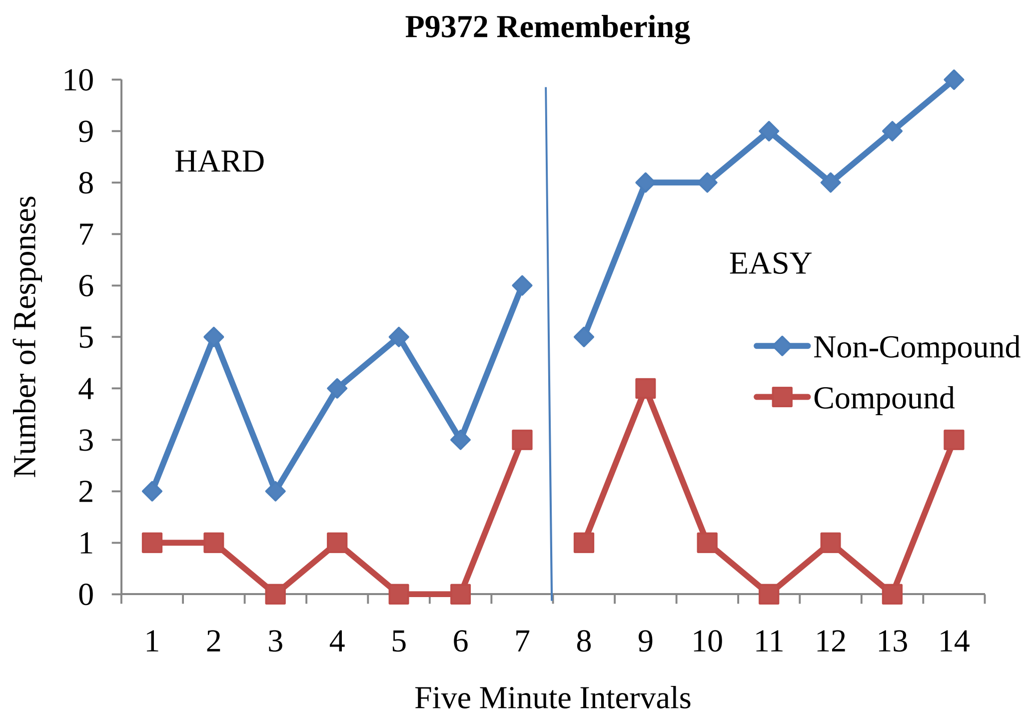

P9771 Remembering
Number of Responses
10
9
8
7
6
5
4
3
2
1
0
EASY
HARD
Non-Compound
Compound
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Five Minute Intervals


P0469 Remembering
EASY
HARD
Non-Compound
Compound
Number of Responses
0
1
2
3
4
5
6
7
8
9
10
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Five Minute Intervals

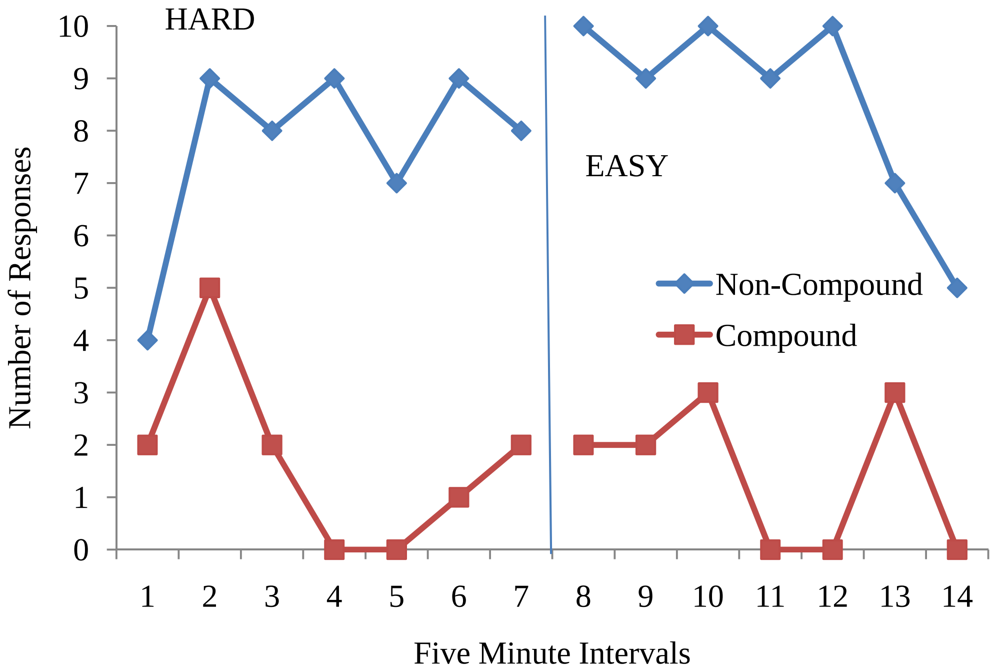

P2482 Remembering
EASY
HARD
Non-Compound
Compound
Number of Responses
0
1
2
3
4
5
6
7
8
9
10
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Five Minute Intervals

APPENDIX A2
HARD-EASY INDIVIDUAL REMEMBERING

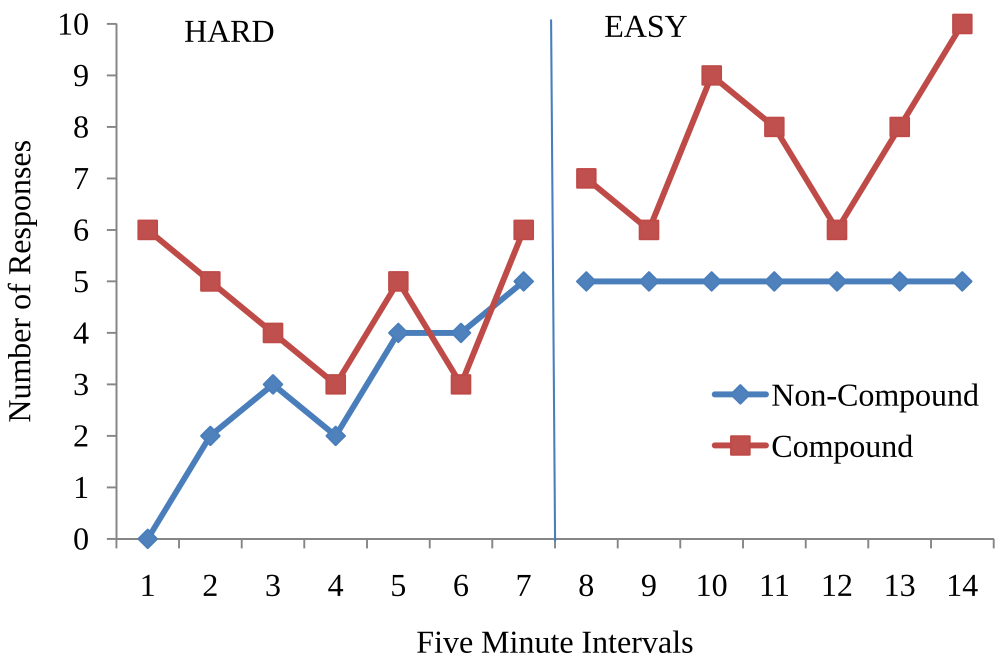




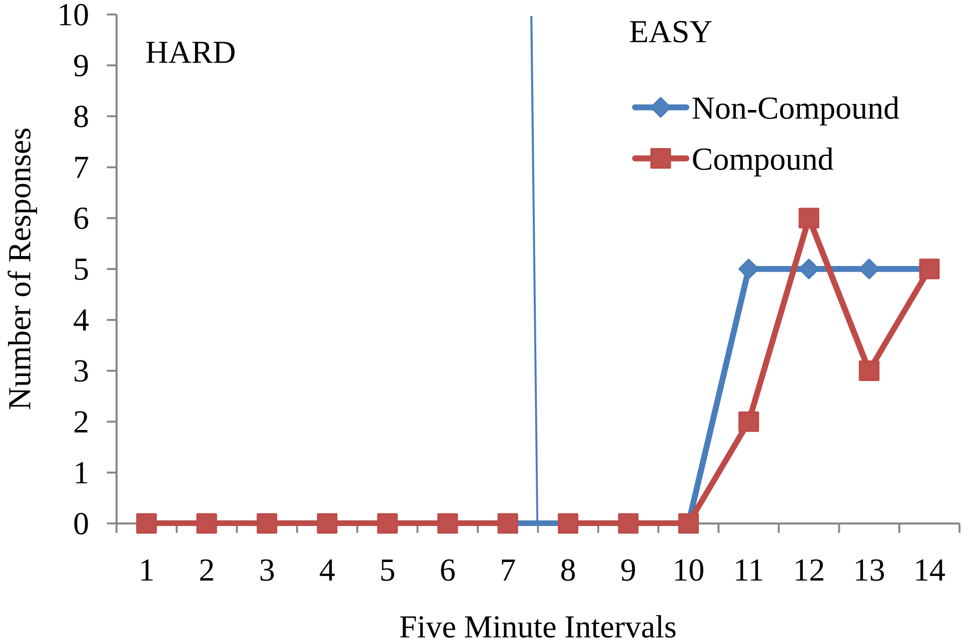
P2288 Remembering Data



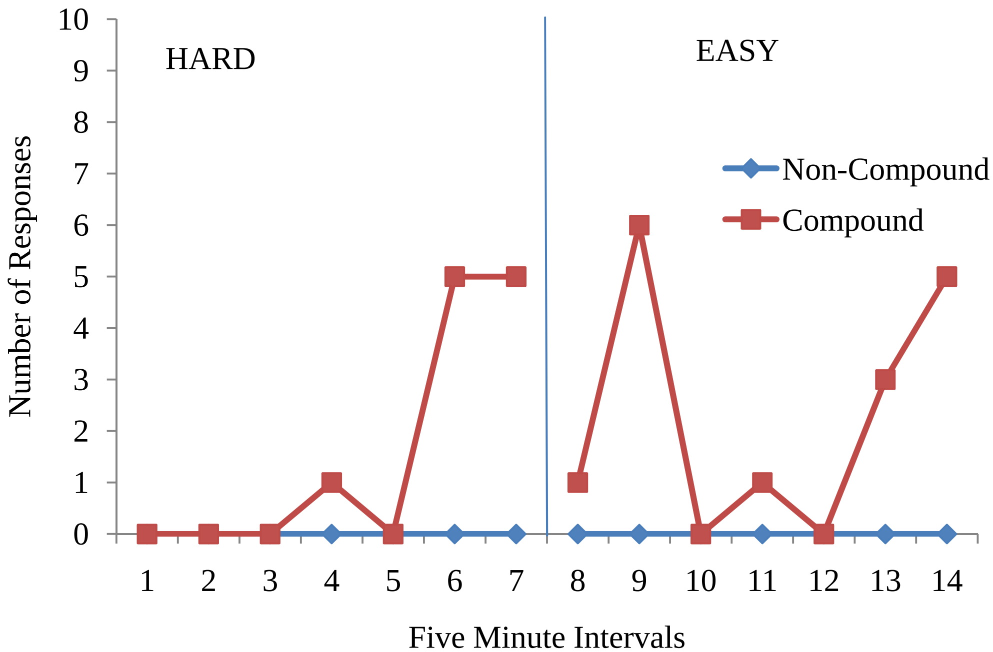
P7110 Remembering



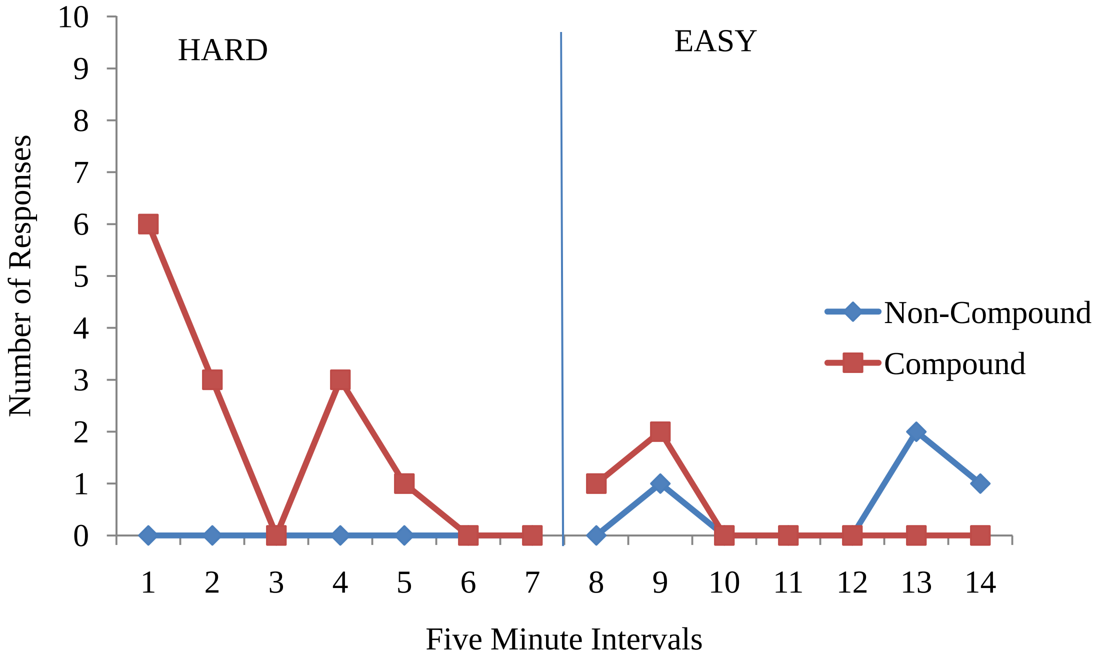
P7393 Remembering



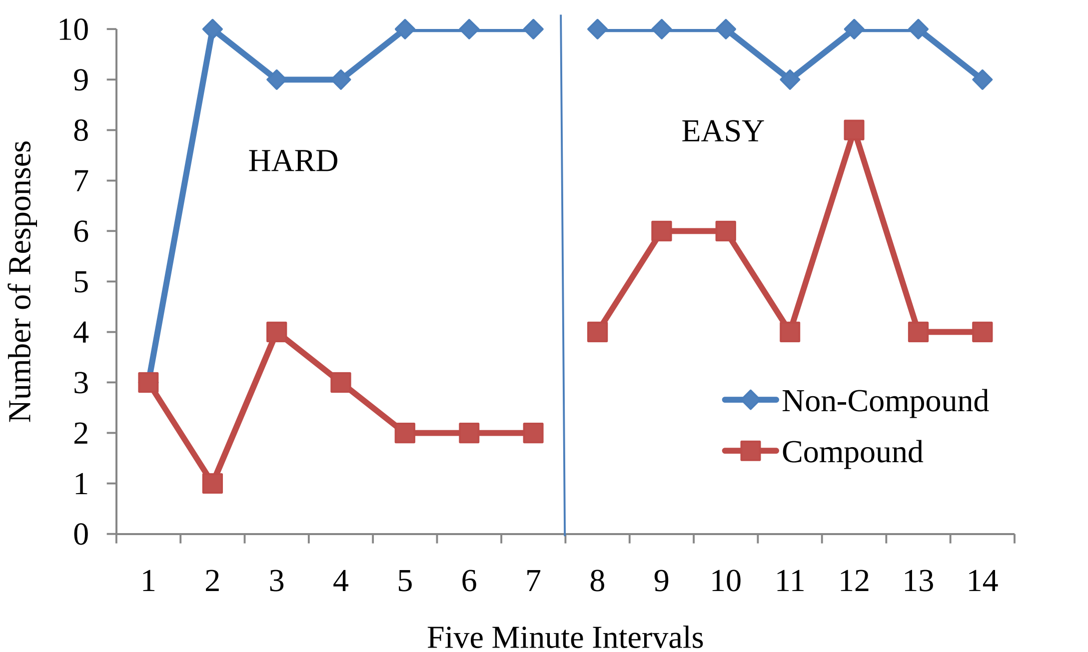
P7594 Remembering



P3831 Remembering

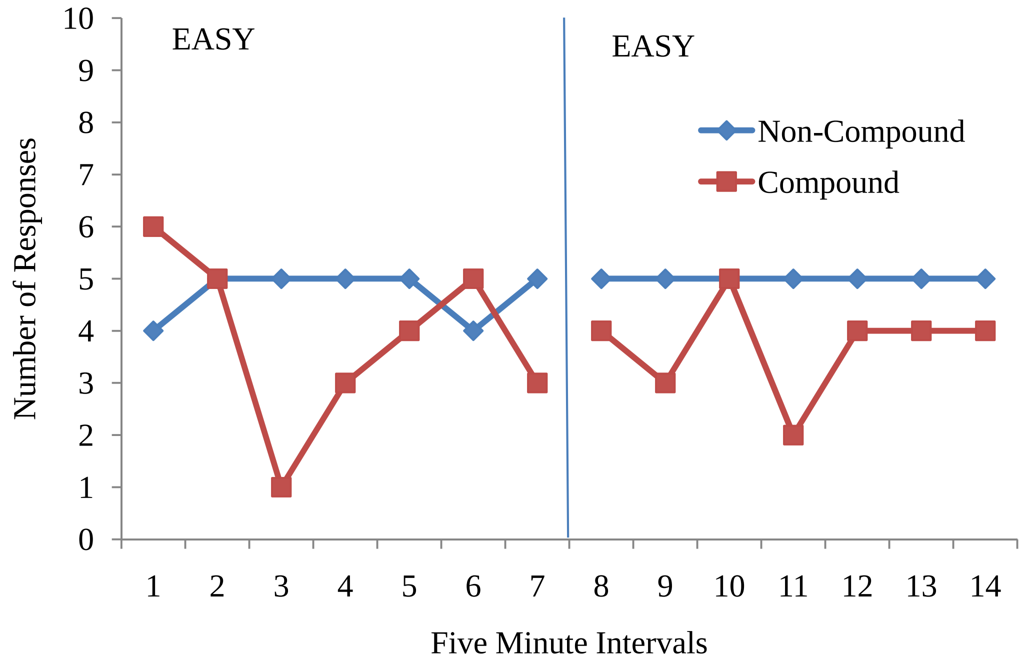


P3108 Remembering

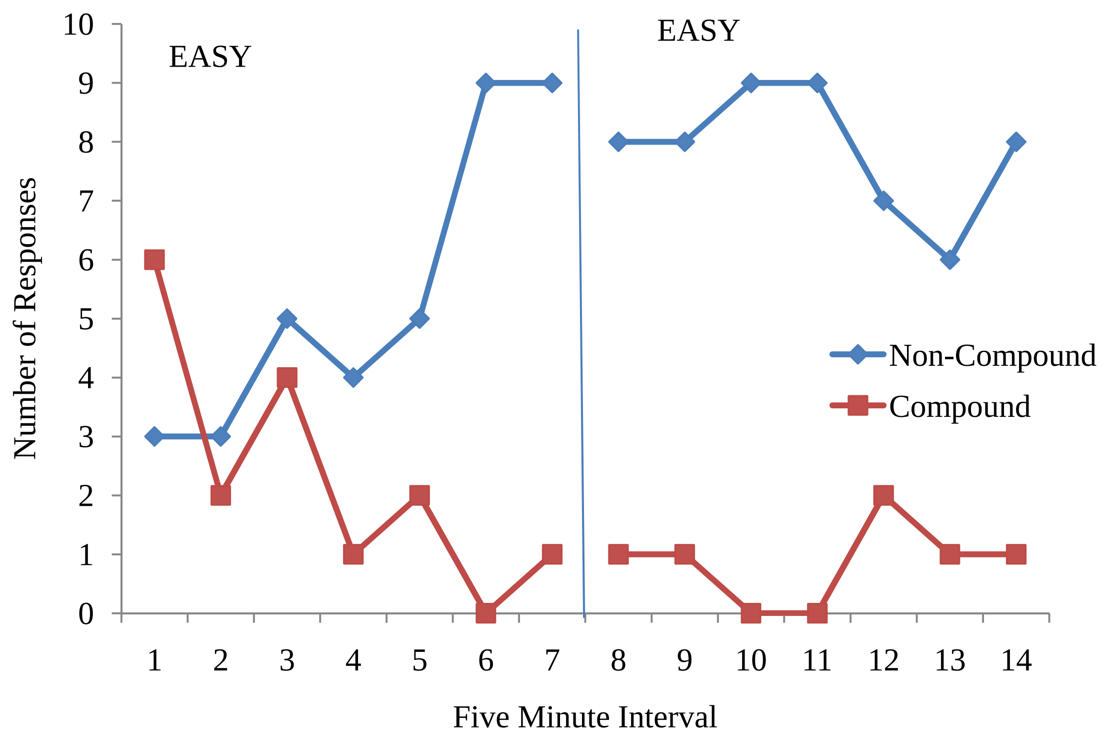


APPENDIX A3
EASY-EASY INDIVIDUAL REMEMBERING

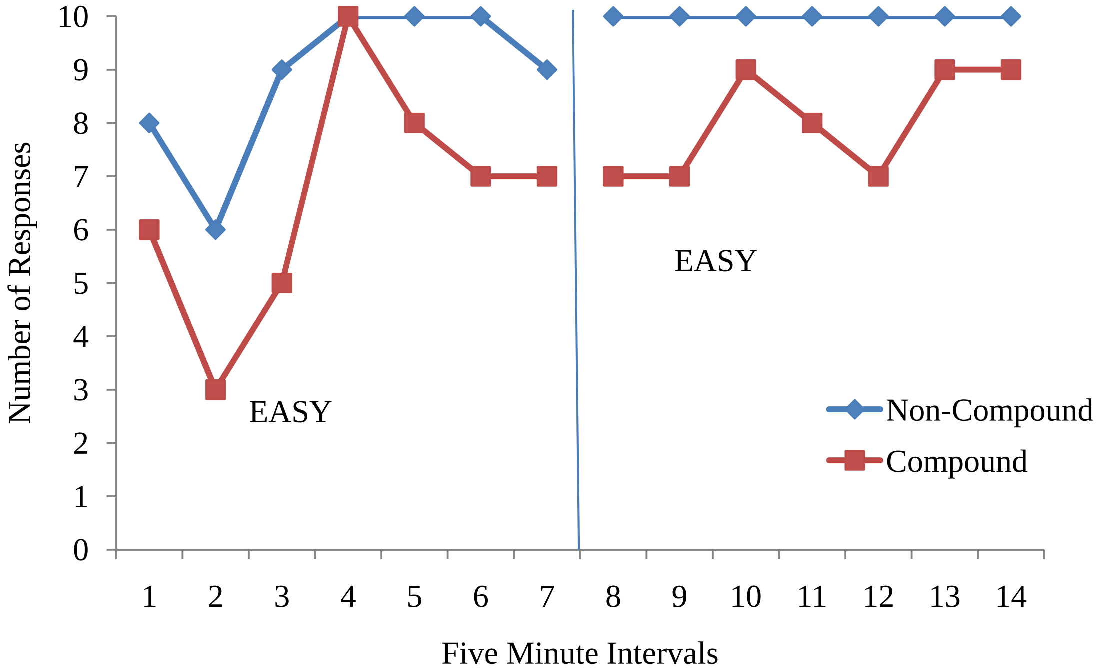
P2268 Remembering Data



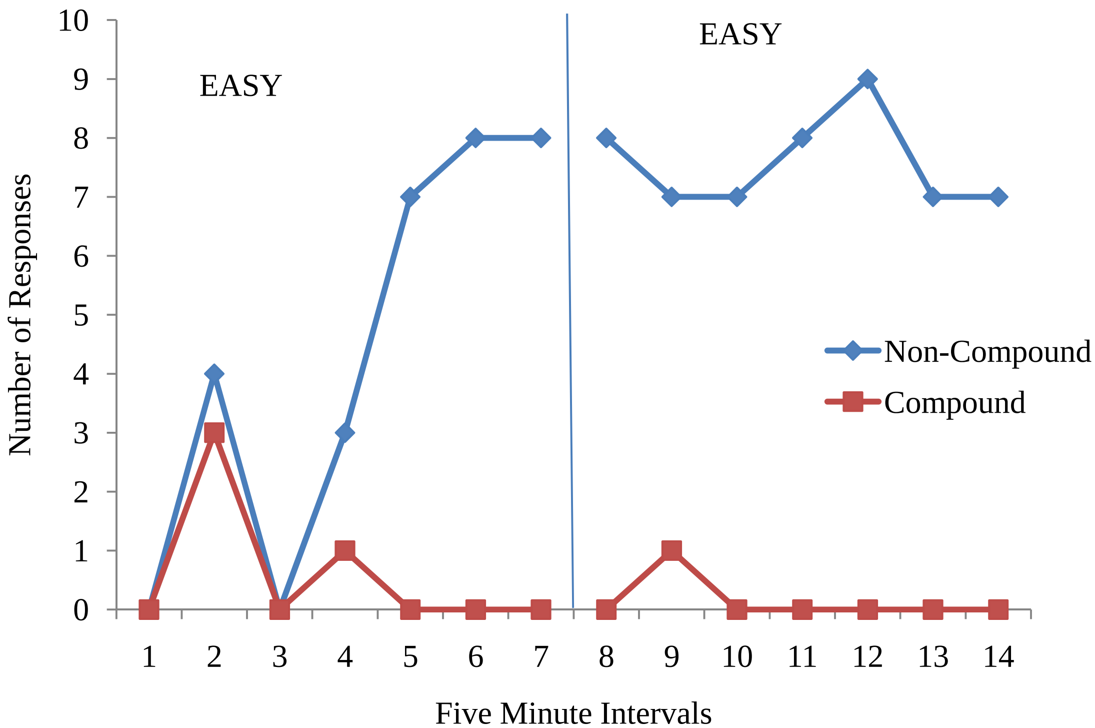
P3661 Remembering

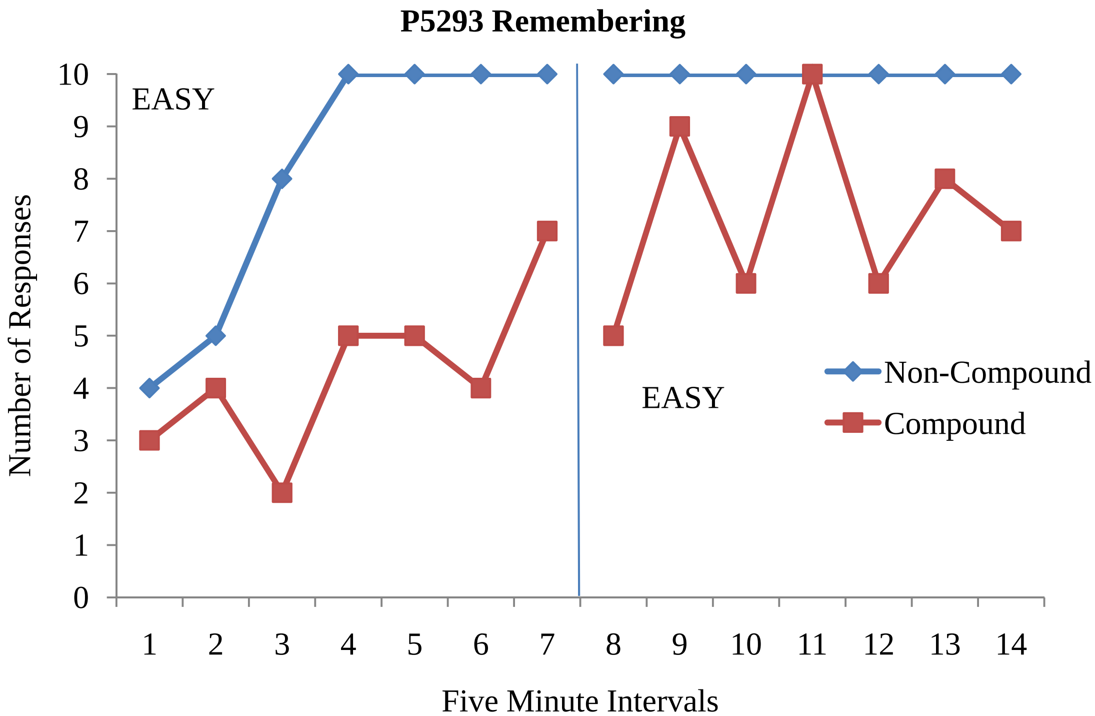


P9809 Remembering

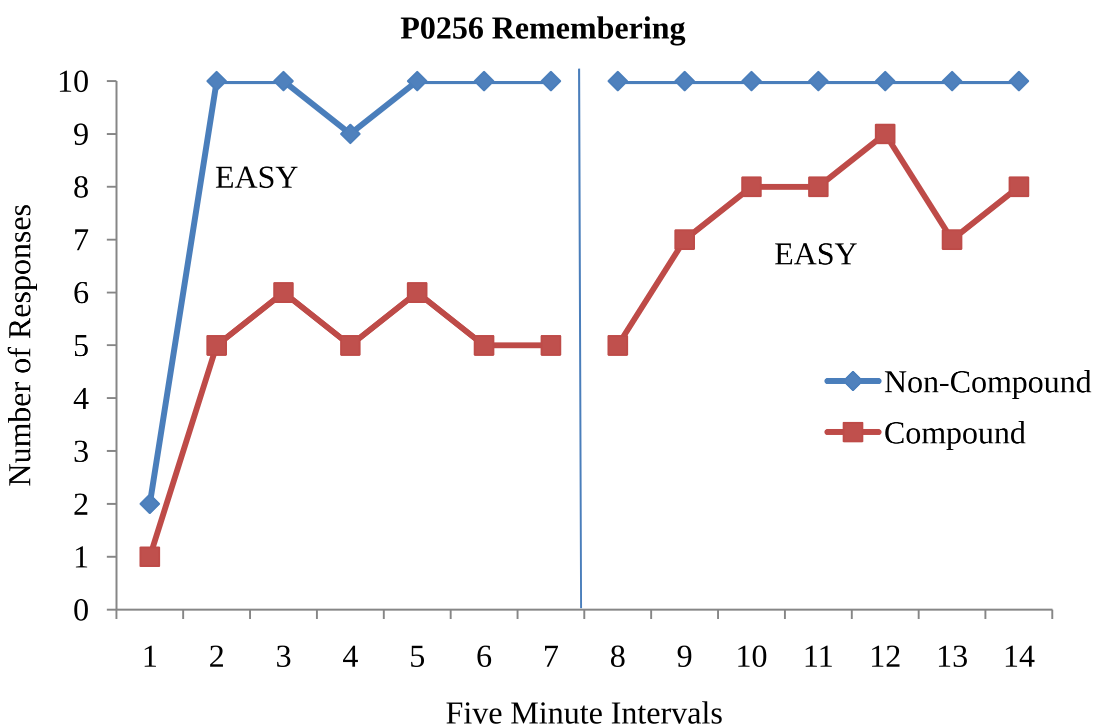


P3696 Remembering



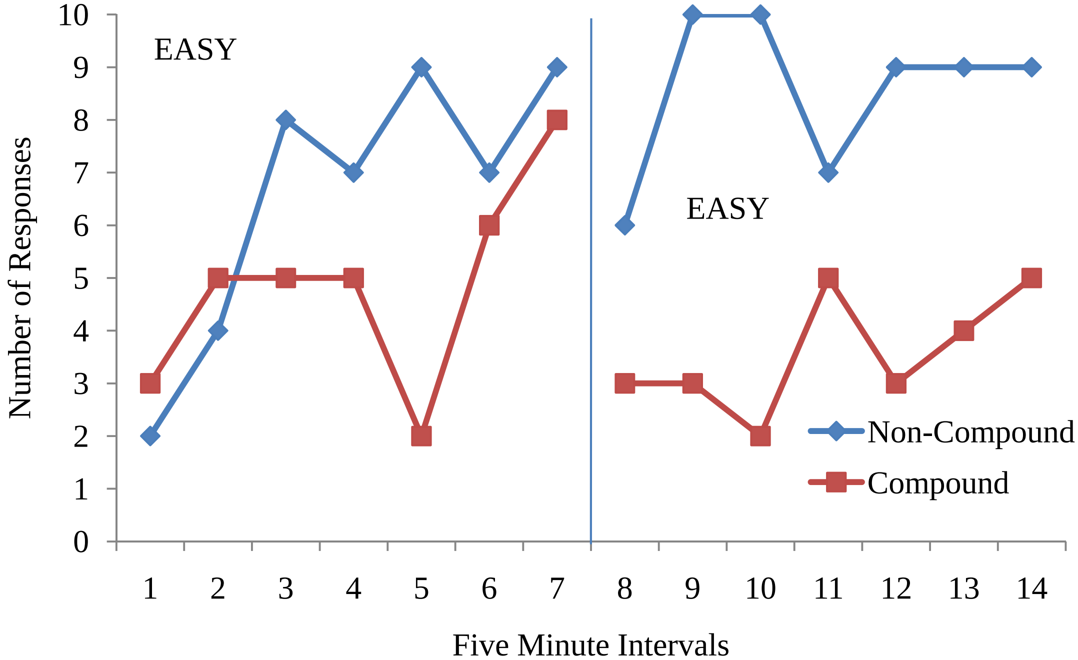


P5293 Remembering
EASY
EASY
Non-Compound
Compound
Number of Responses
Five Minute Intervals

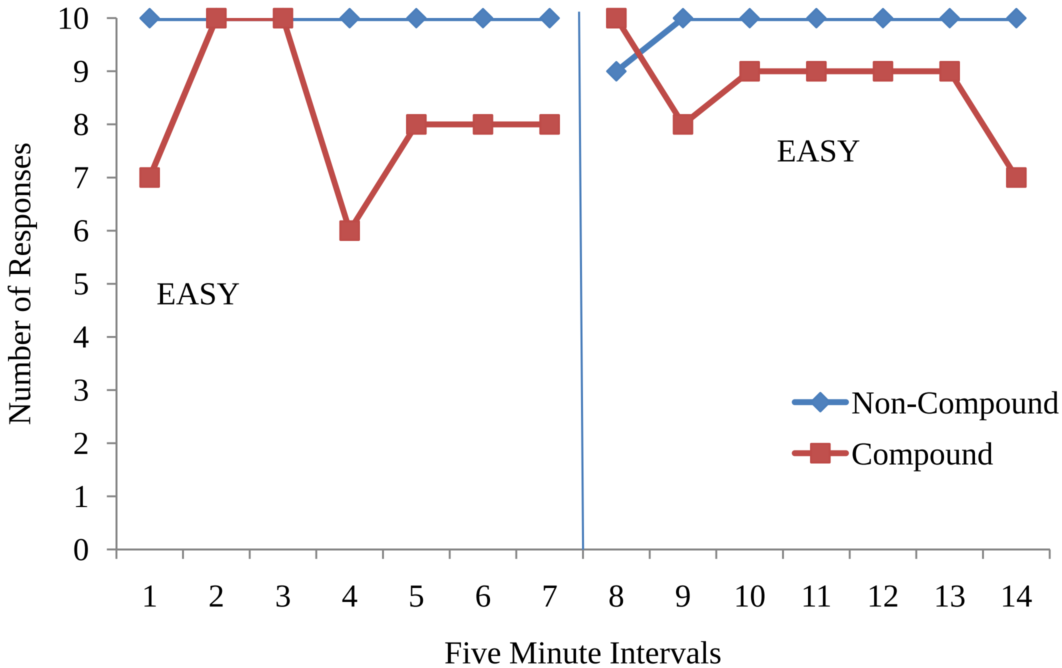


P0256 Remembering
EASY
EASY
Non-Compound
Compound
Number of Responses
Five Minute Intervals

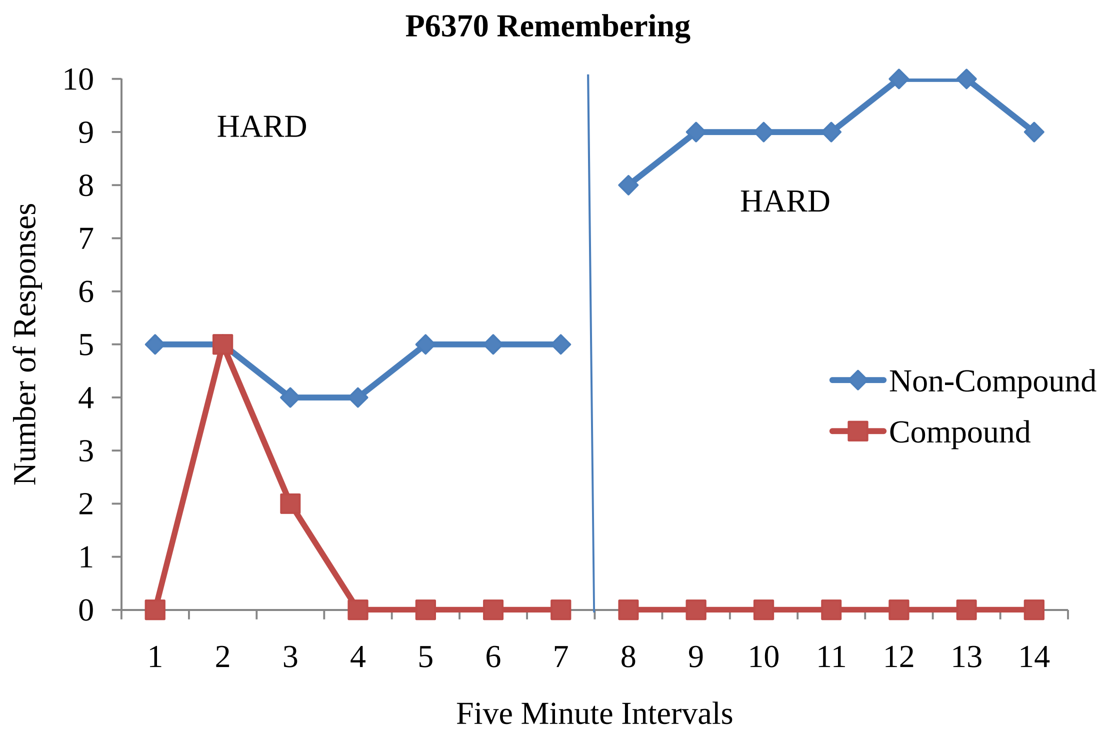
P9157 Remembering

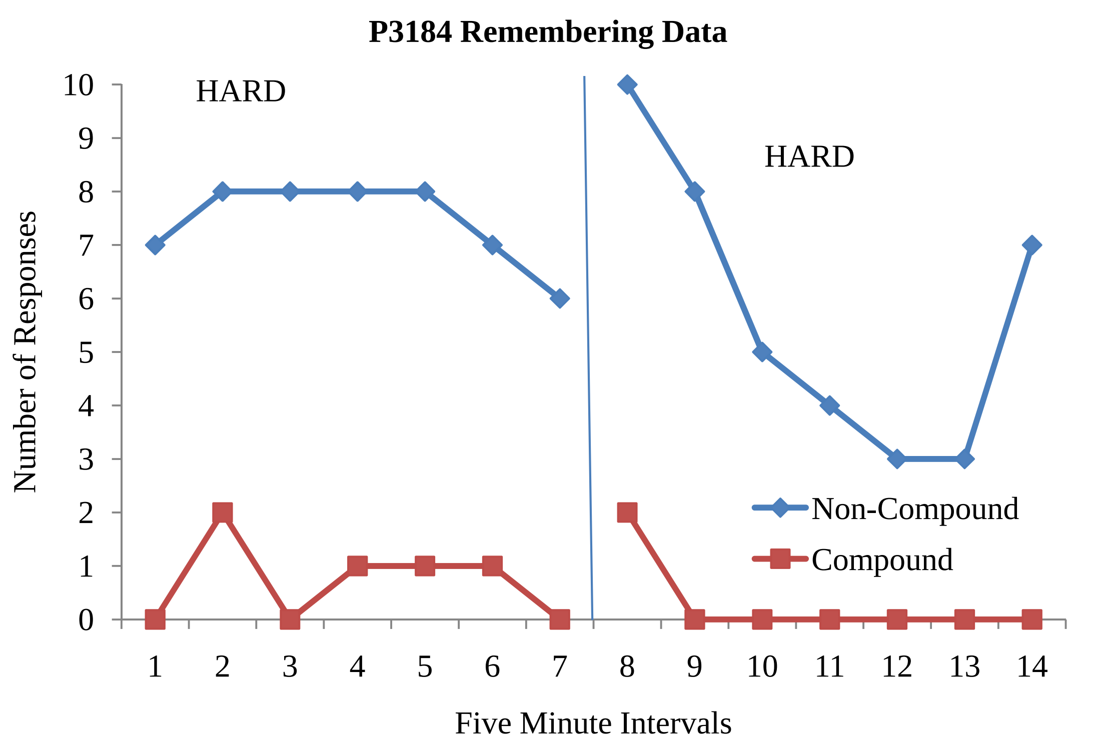


P8691 Remembering

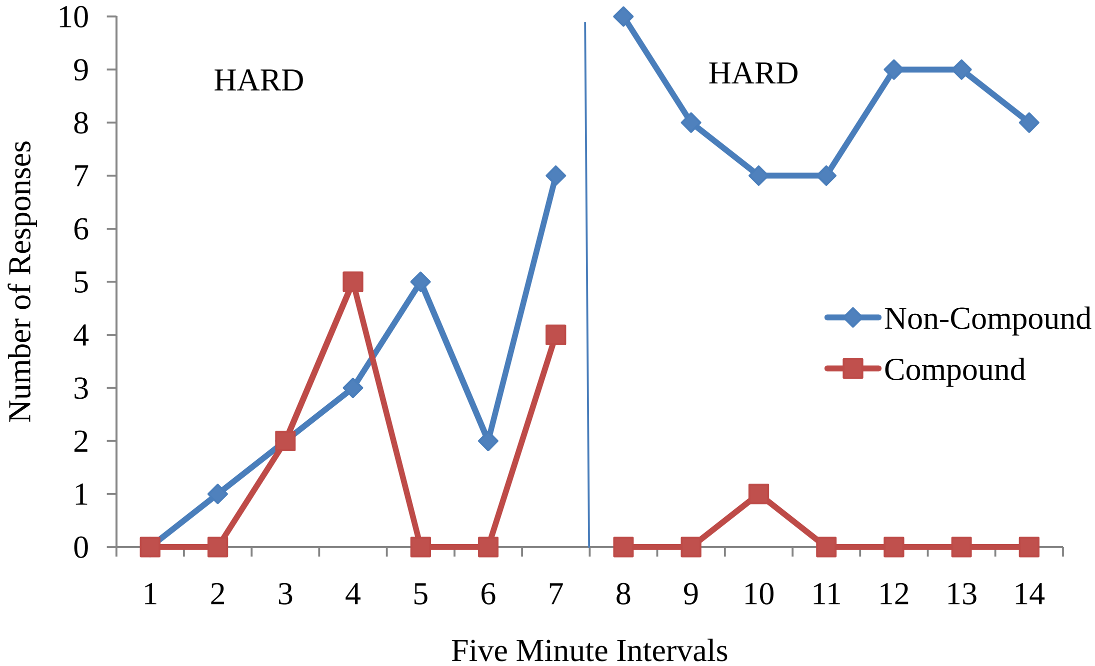


APPENDIX A4
HARD-HARD INDIVIDUAL REMEMBERING

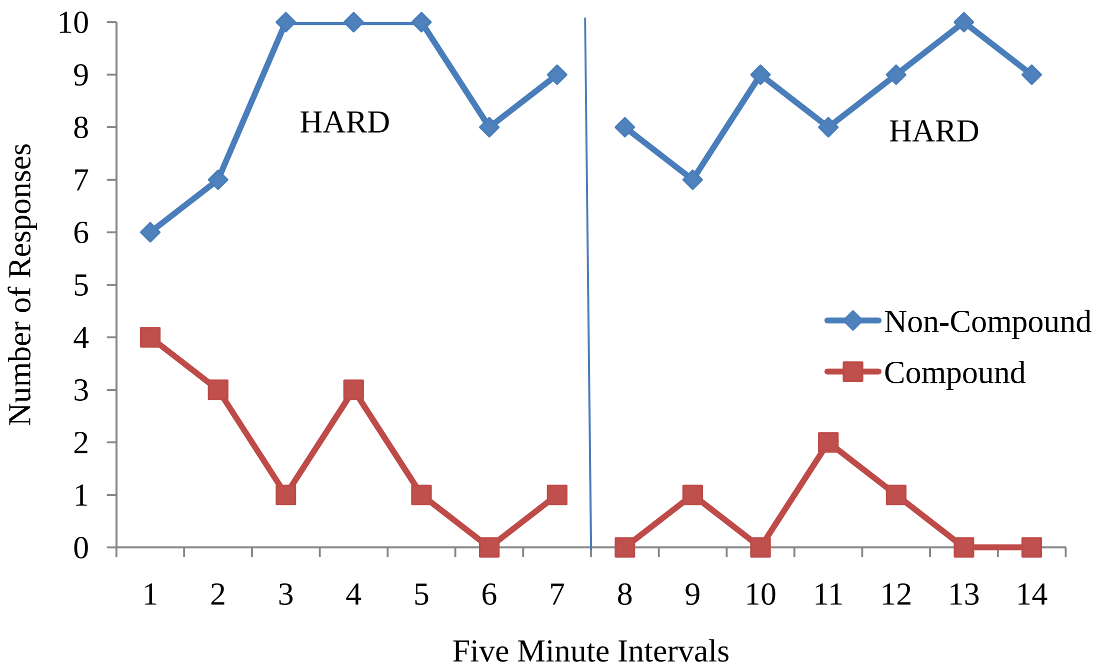




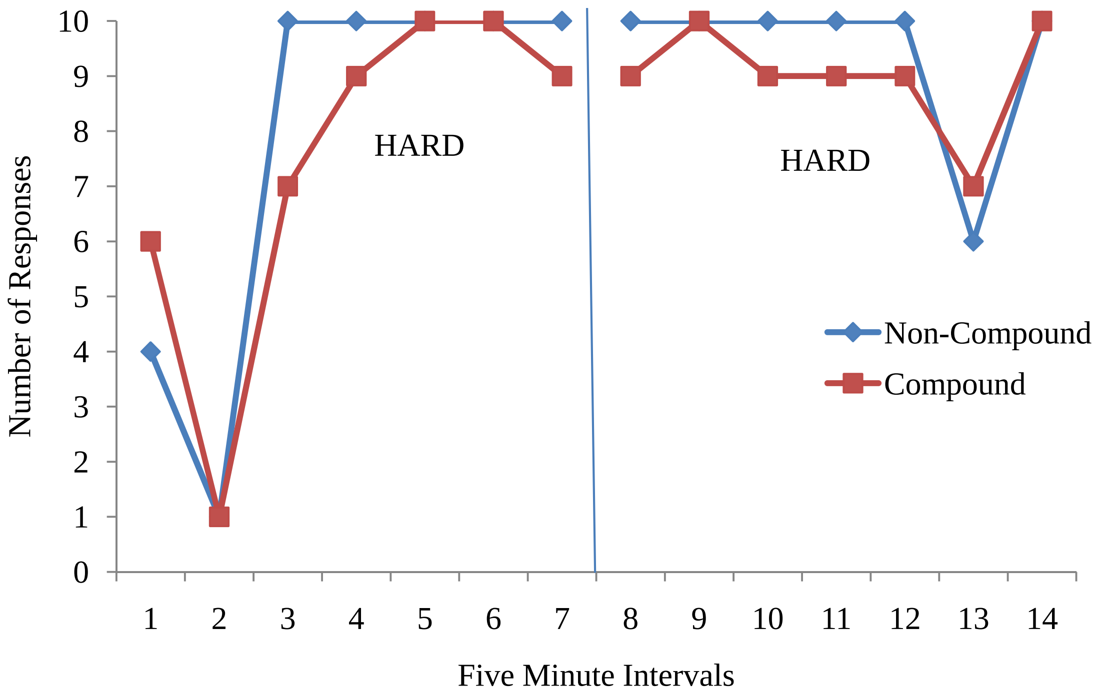
P1161 Remembering



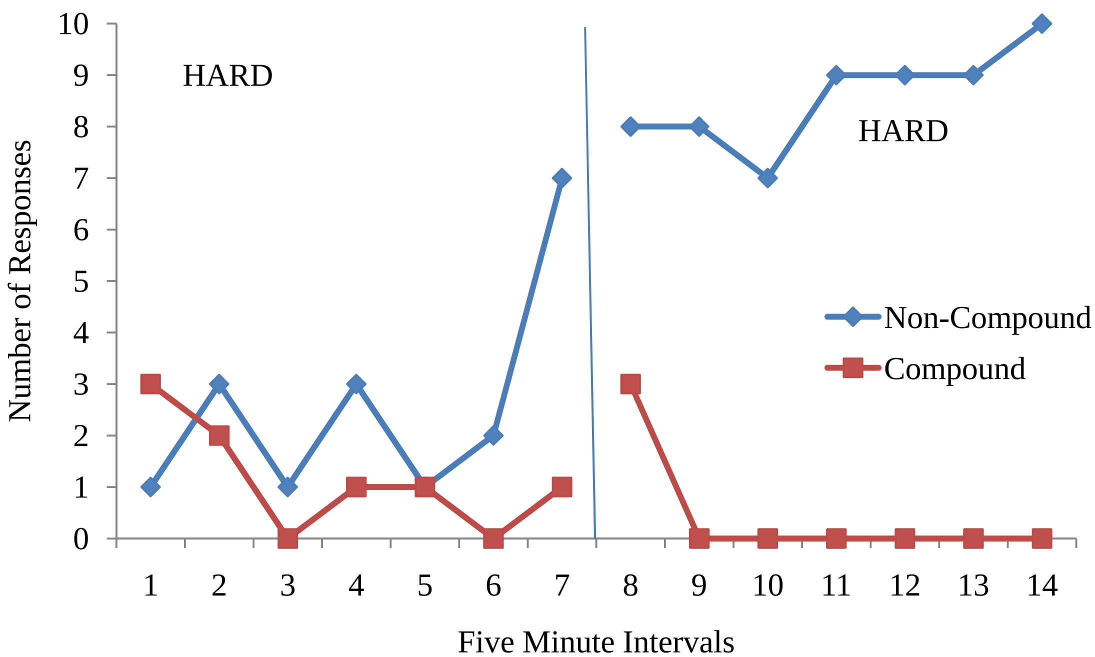
P5209 Remembering

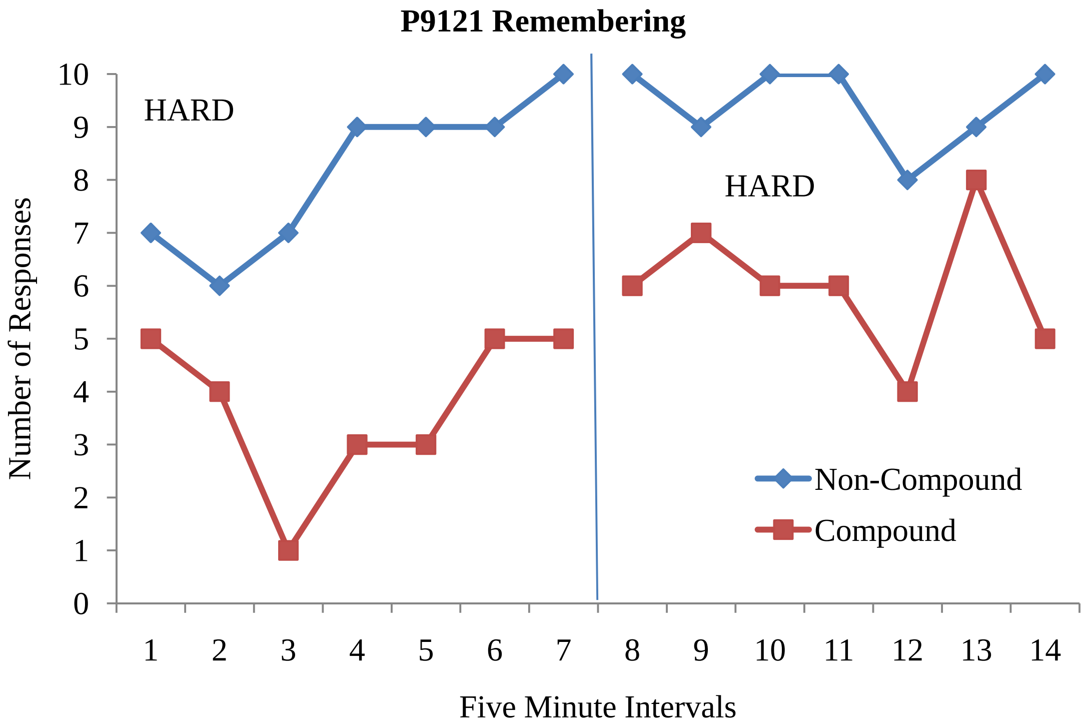


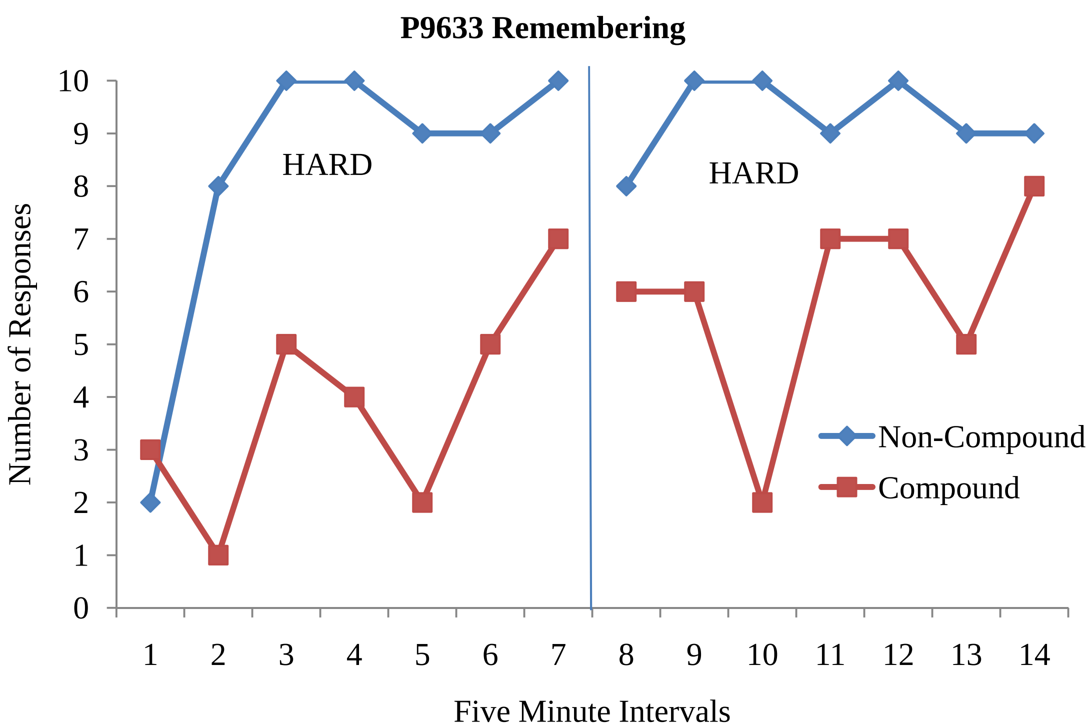
P2942 Remembering



P7945 Remembering

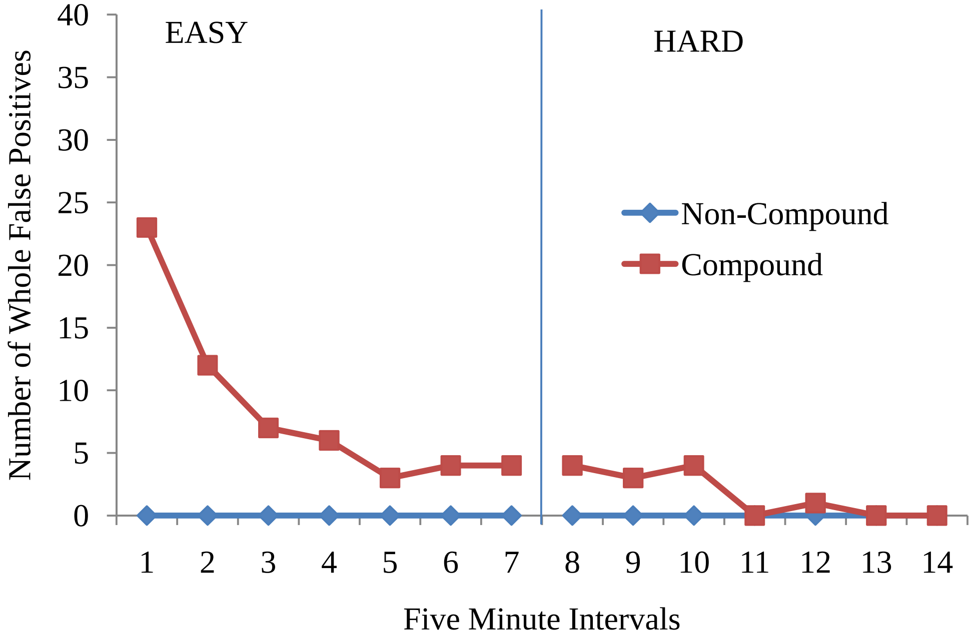



P9121 Remembering
HARD
HARD
Non-Compound
Compound
Number of Responses
Five Minute Intervals
0
1
2
3
4
5
6
7
8
9
10
1
2
3
4
5
6
7
8
9
10
11
12
13
14

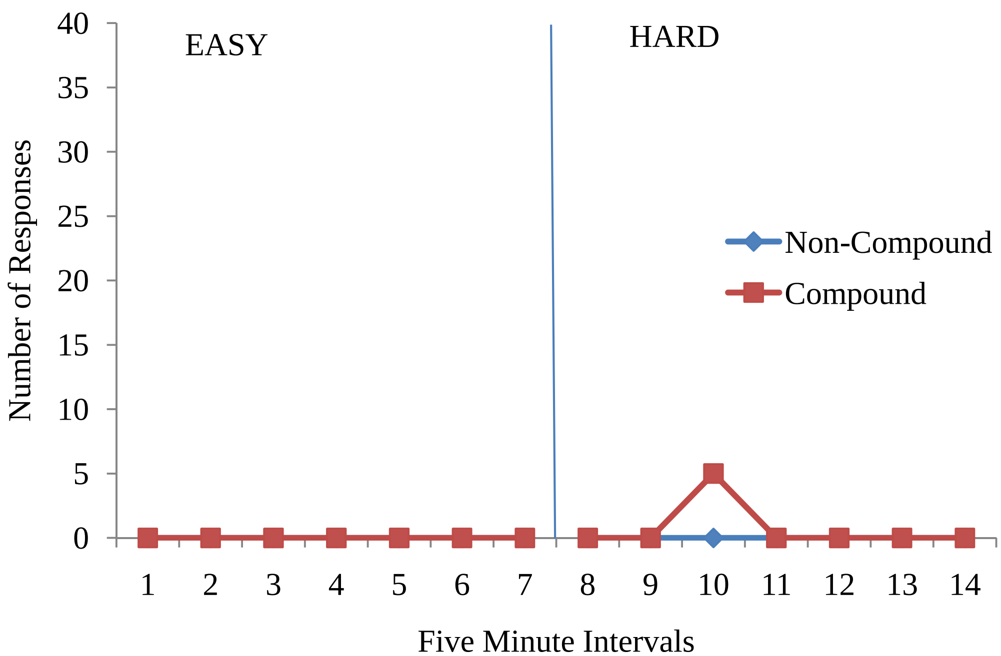

P9633 Remembering
HARD
HARD
Non-Compound
Compound
Number of Responses
Five Minute Intervals
0
1
2
3
4
5
6
7
8
9
10
1
2
3
4
5
6
7
8
9
10
11
12
13
14

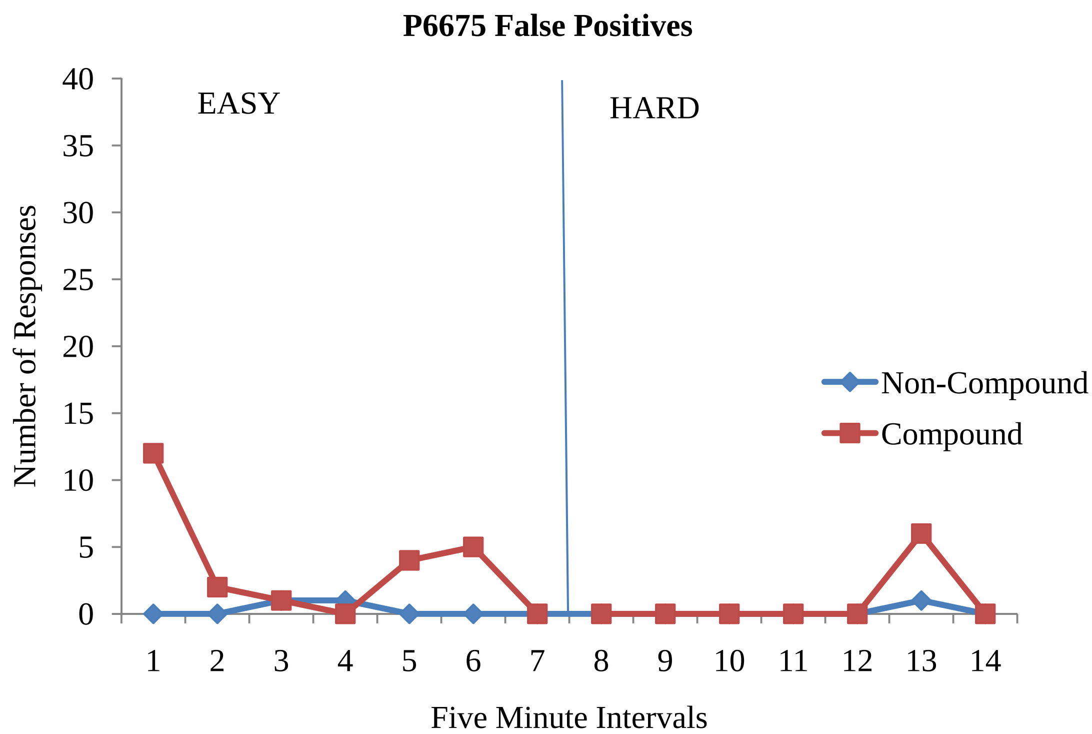
APPENDIX B1
EASY-HARD INDIVIDUAL FALSE POSITIVES

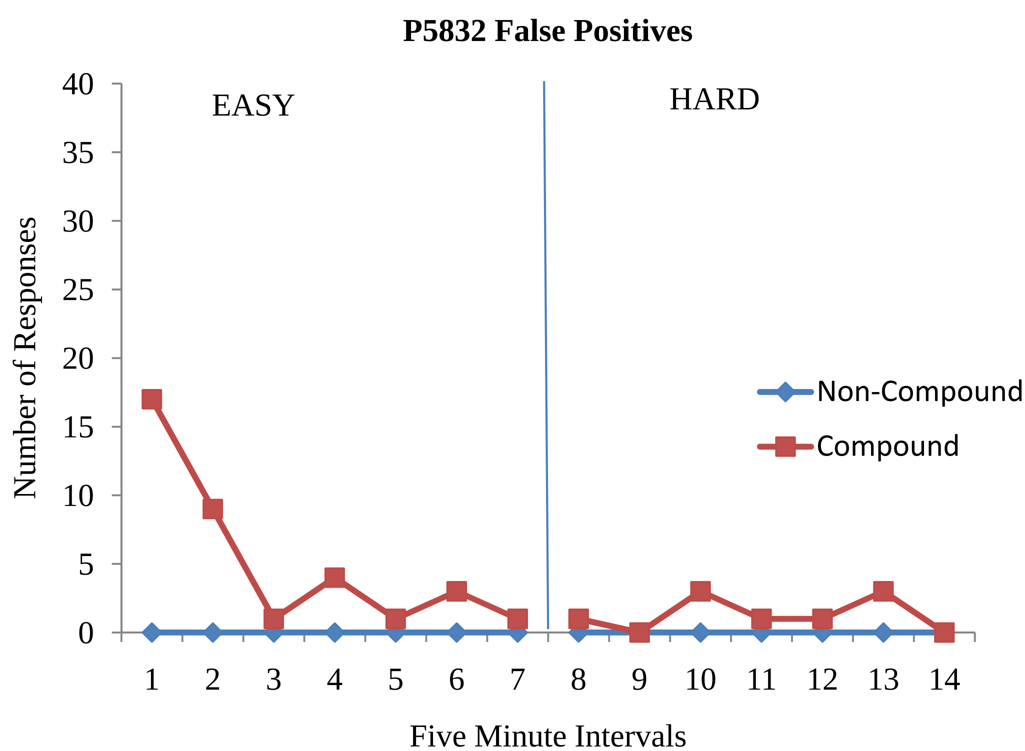
P2904 False Positives



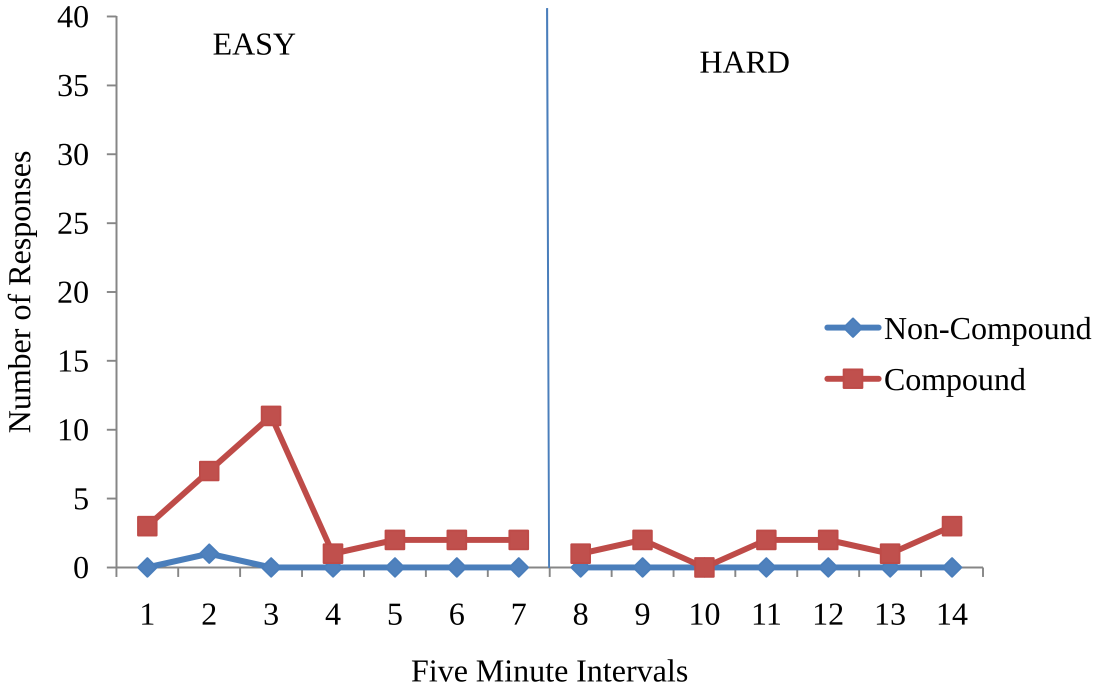
P1180 False Positives



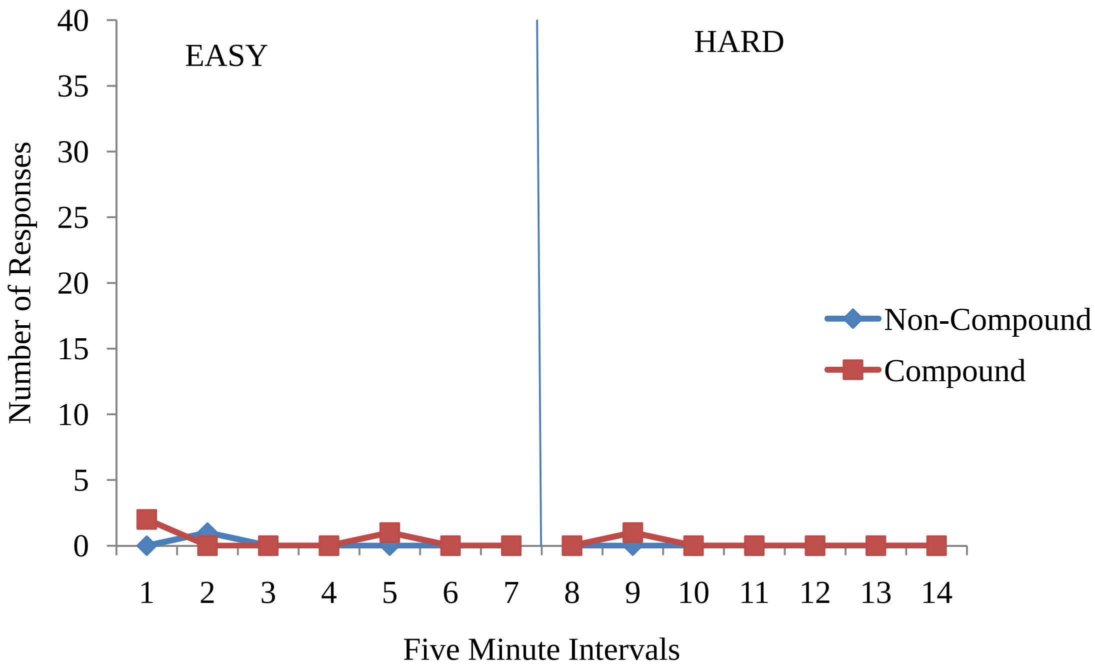

P6675 False Positives
EASY
HARD
Number of Responses
0
5
10
15
20
25
30
35
40
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Five Minute Intervals
Non-Compound
Compound


P5832 False Positives
EASY
HARD
Number of Responses
0
5
10
15
20
25
30
35
40
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Five Minute Intervals
Non-Compound
Compound

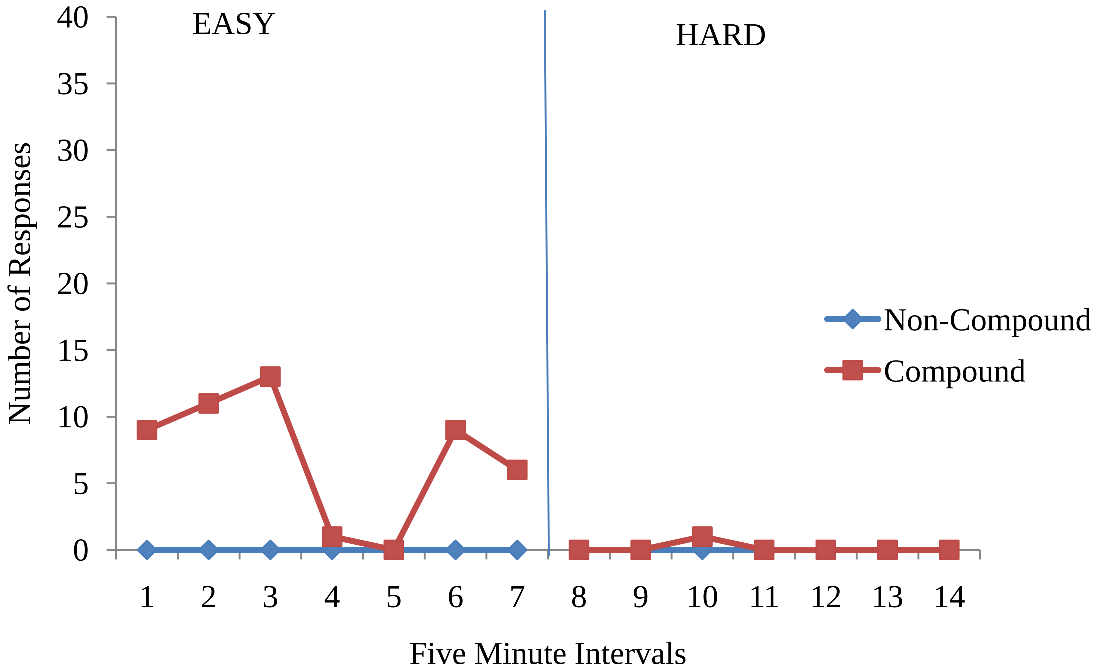
P0549 False Positives



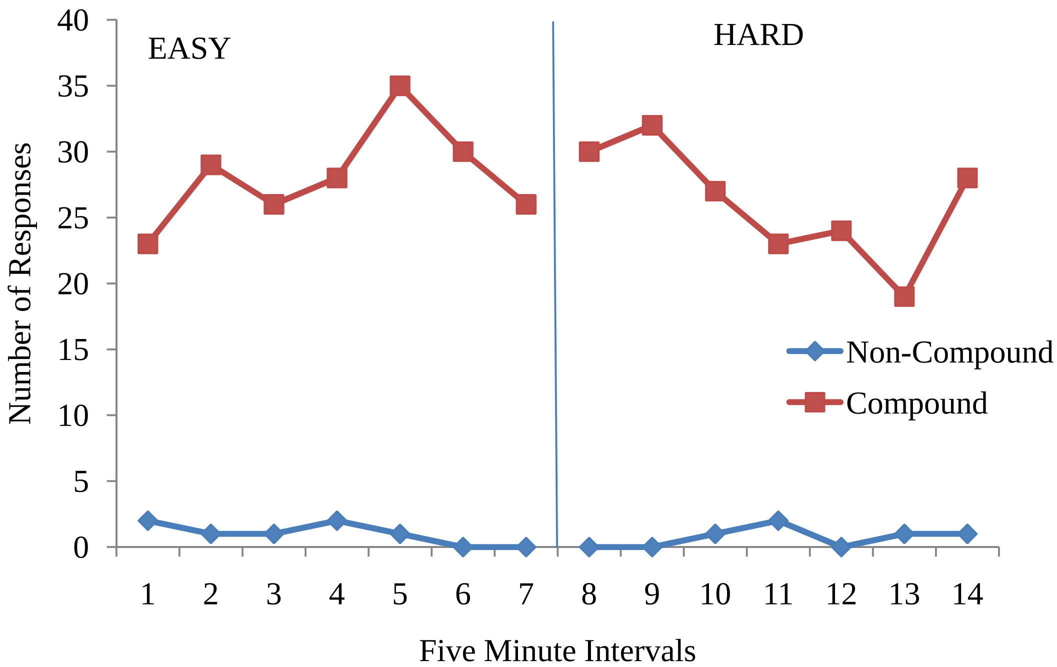
P9771 False Positives



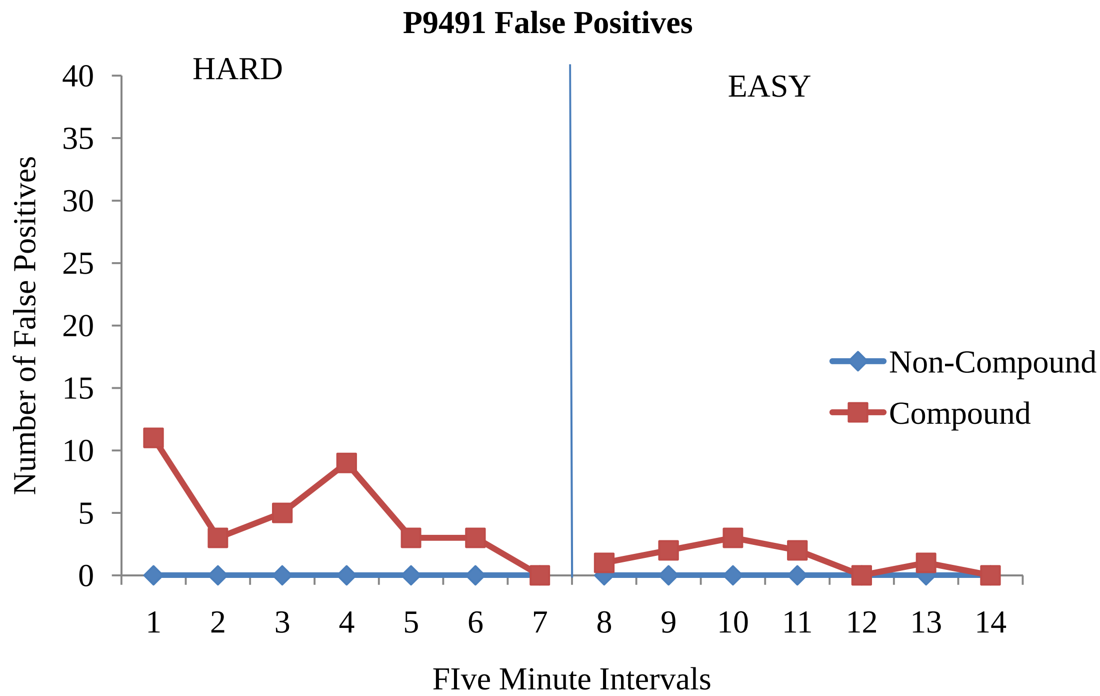
P0469 False Positives

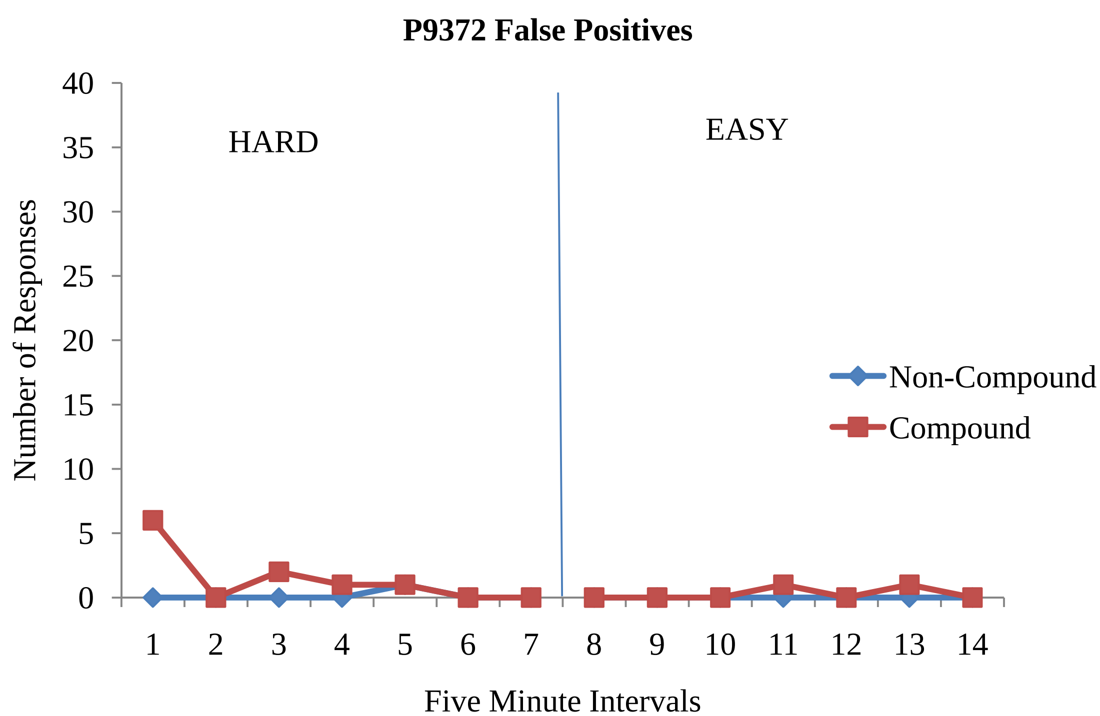


P2482 False Positives

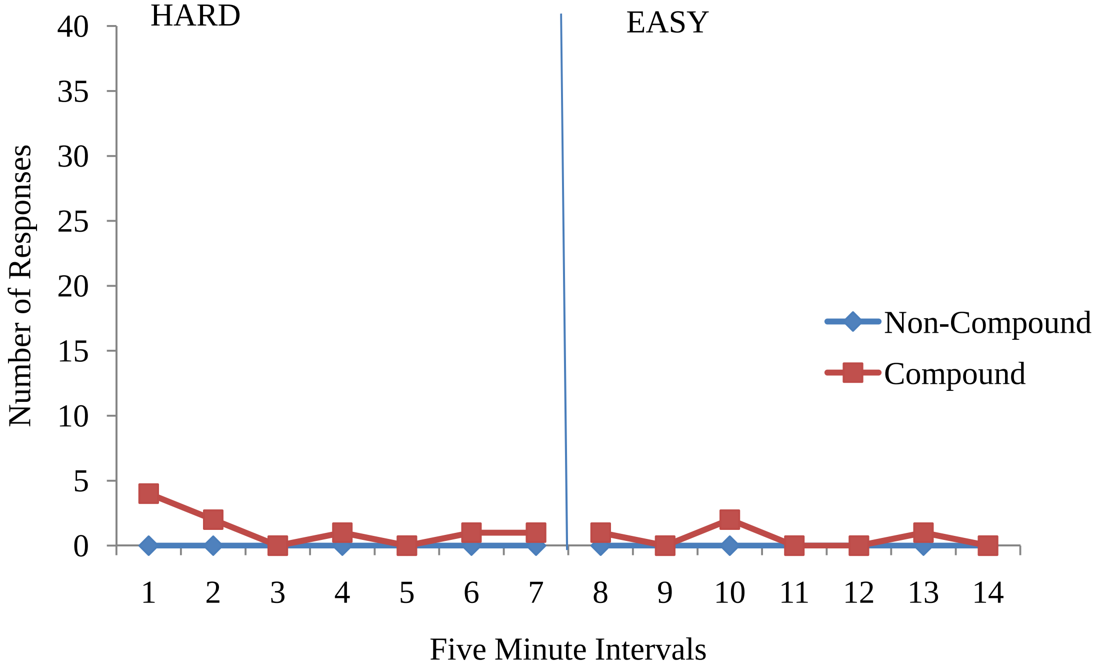


APPENDIX B2
HARD-EASY INDIVIDUAL FALSE POSITIVES

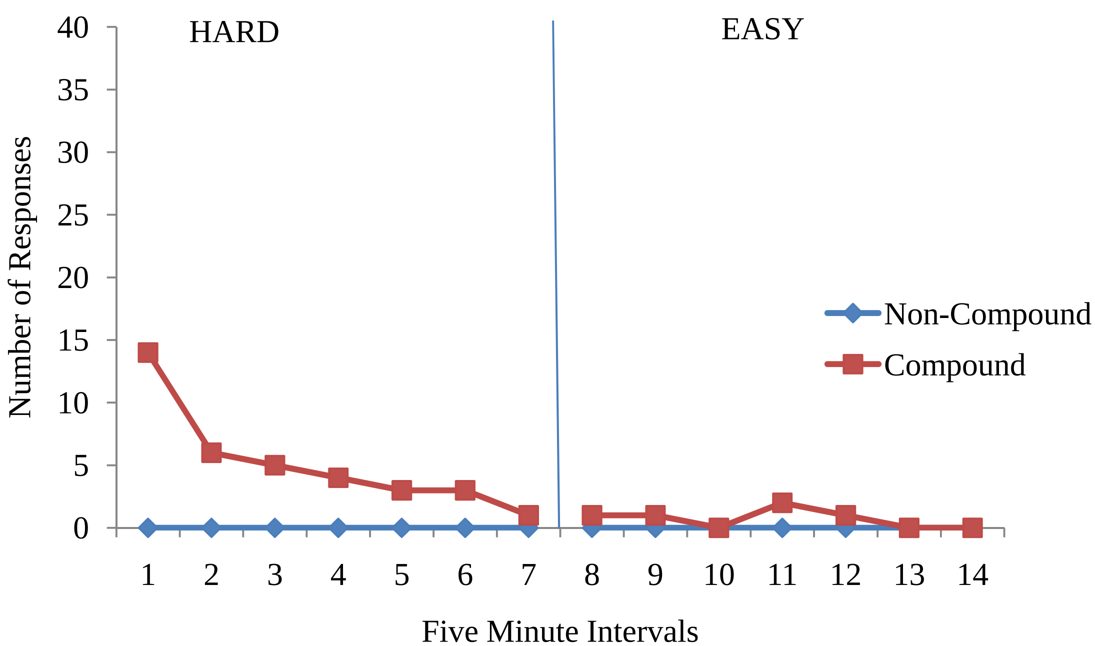




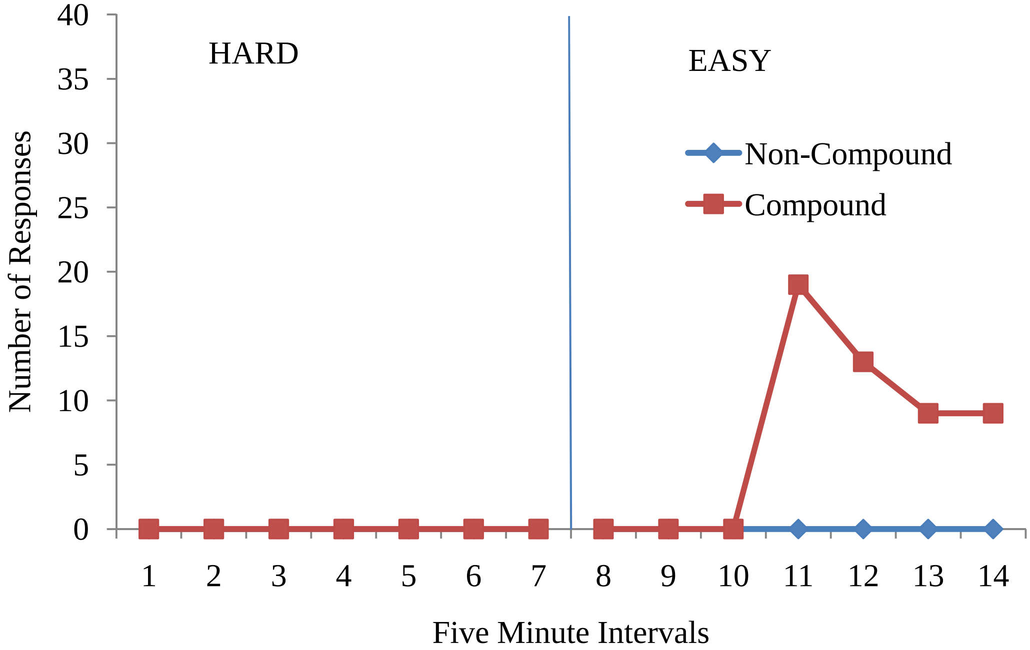
P2288 False Positives



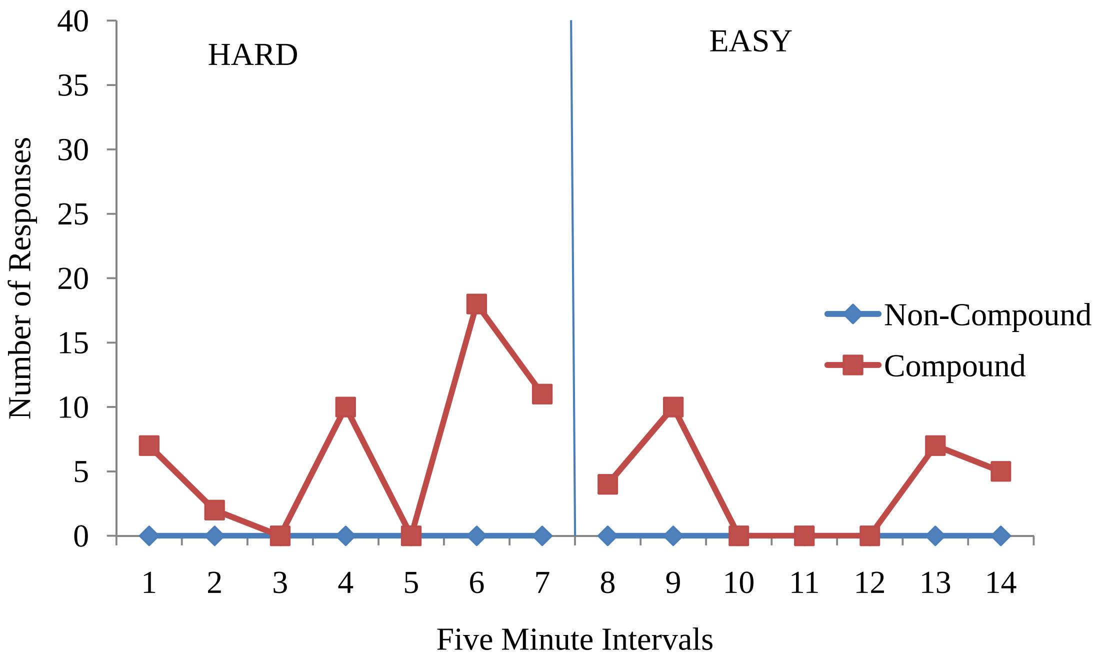
P7110 False Positives

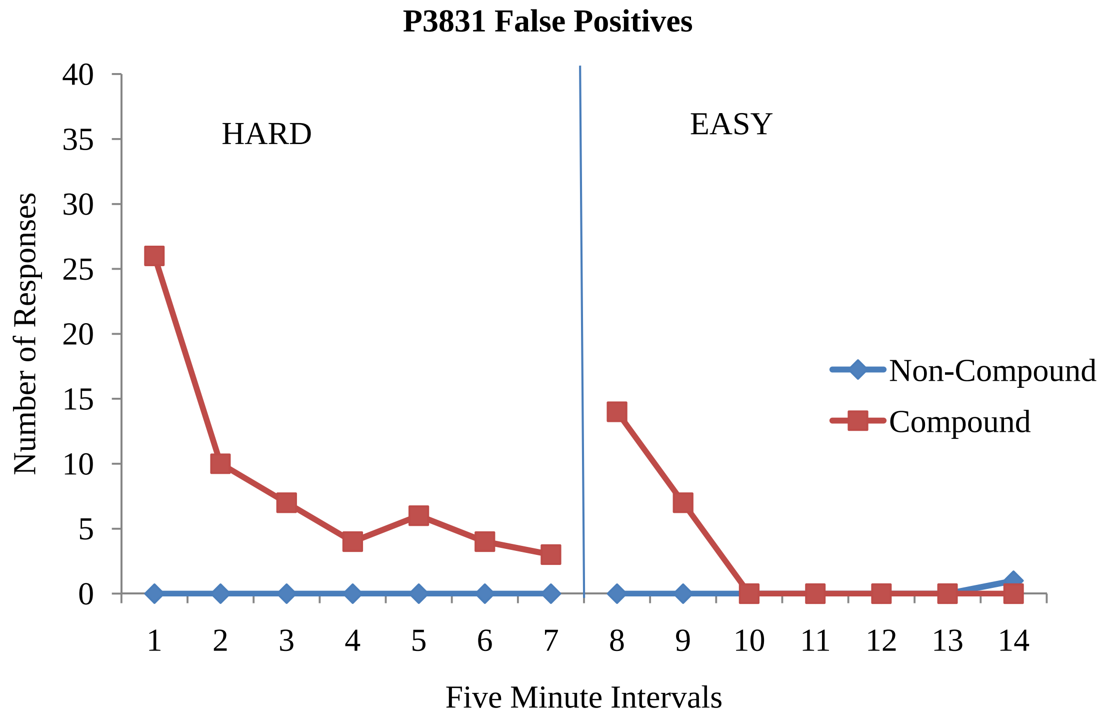


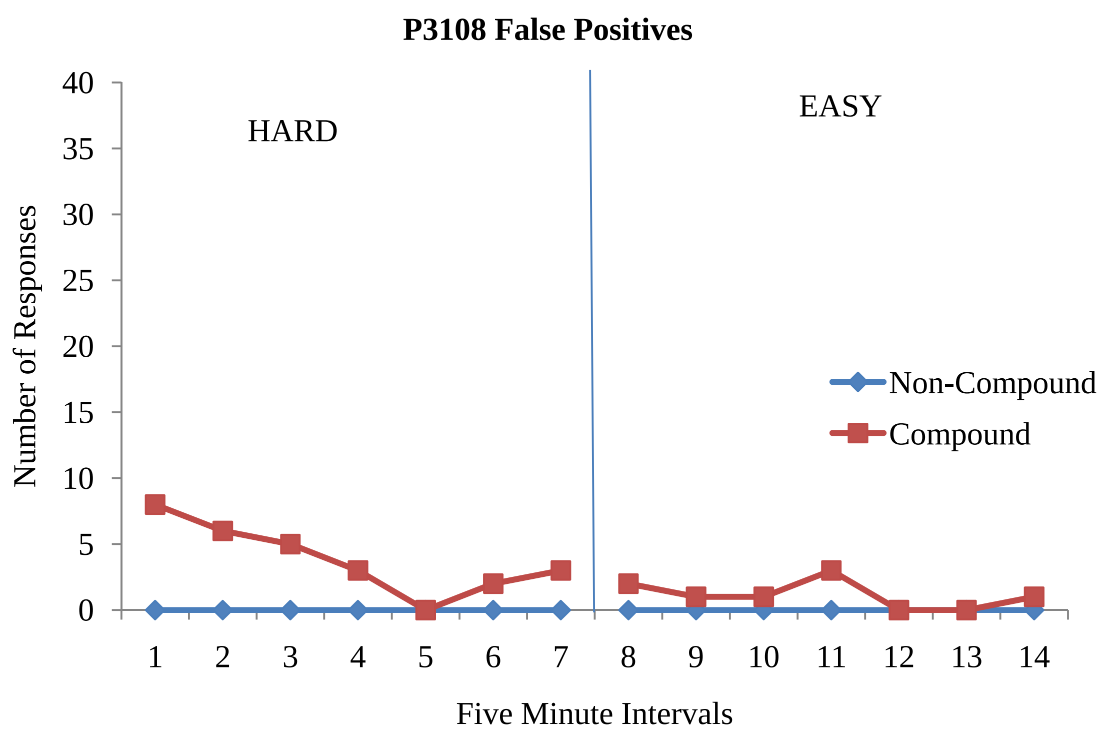
P7393 False Positives



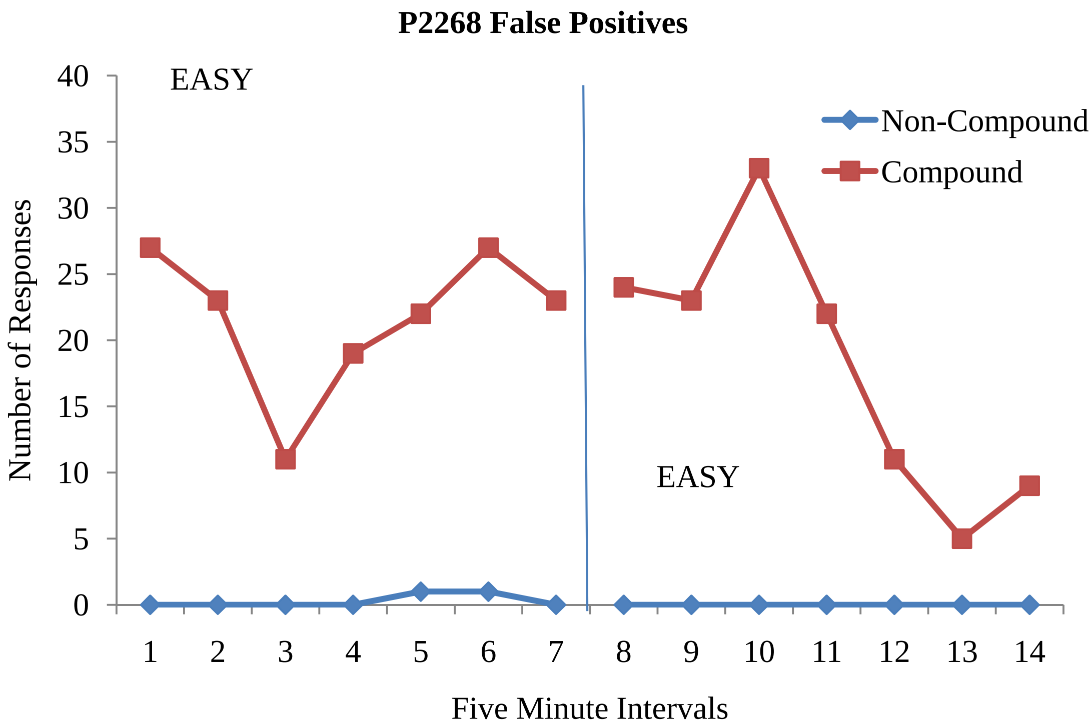
P7594 False Positives

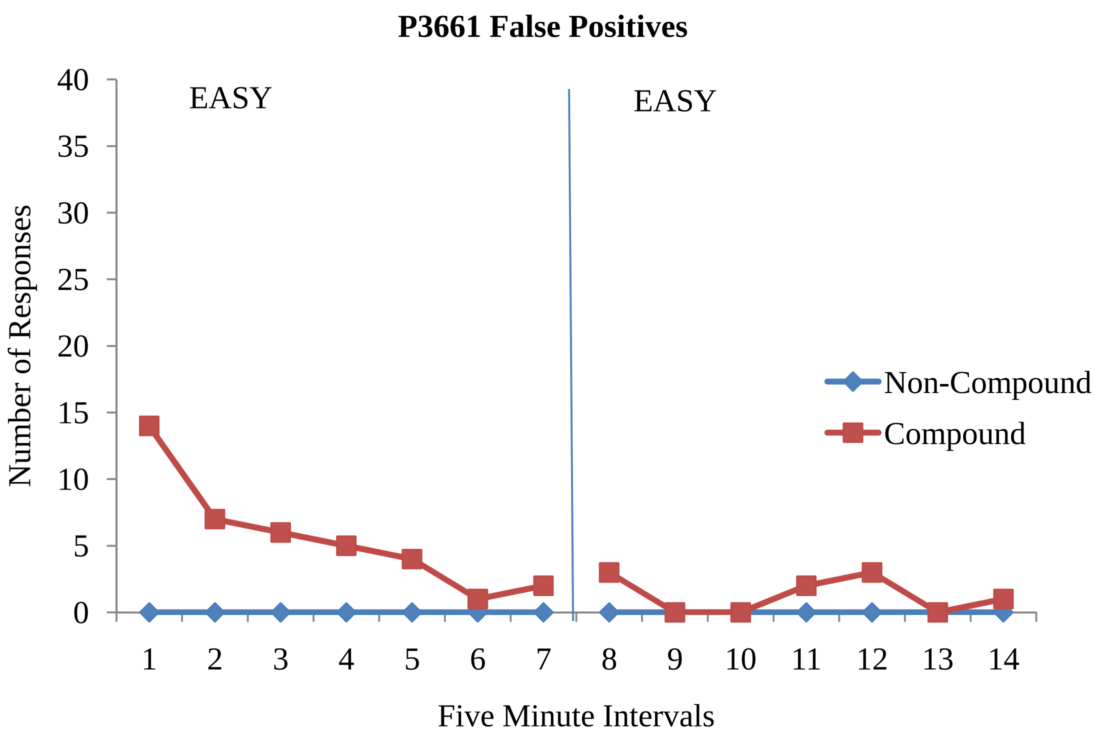



P3831 False Positives
40
35
30
25
20
15
10
5
0
Number of Responses
HARD
EASY
Non-Compound
Compound
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Five Minute Intervals

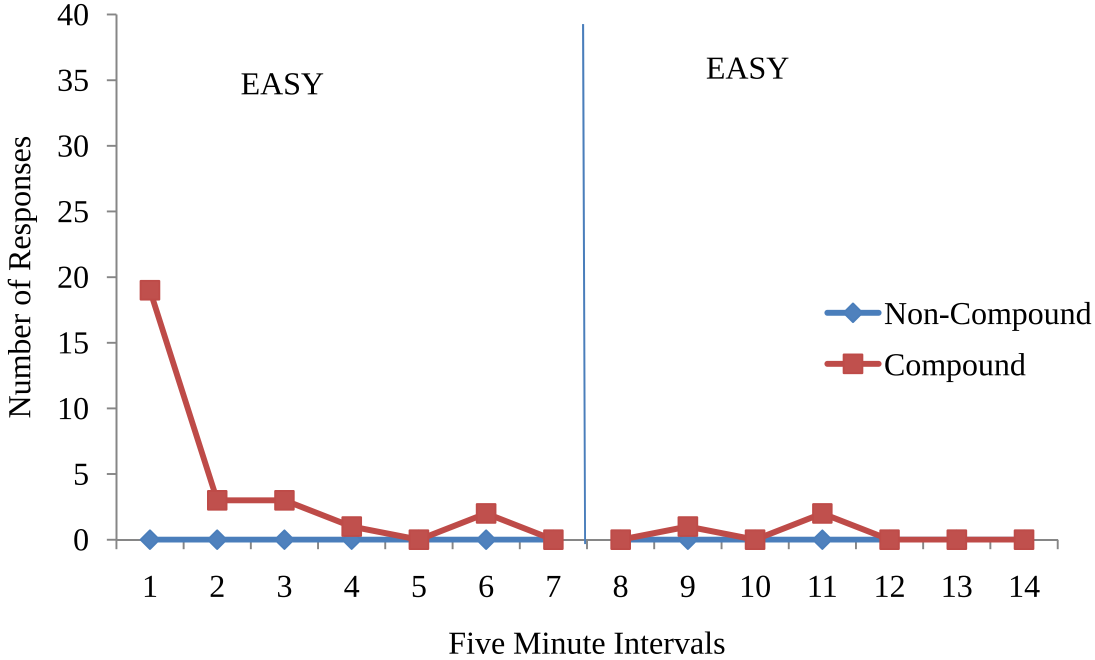

P3108 False Positives
40
35
30
25
20
15
10
5
0
Number of Responses
HARD
EASY
Non-Compound
Compound
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Five Minute Intervals

APPENDIX B3
EASY-EASY INDIVIDUAL FALSE POSITIVES

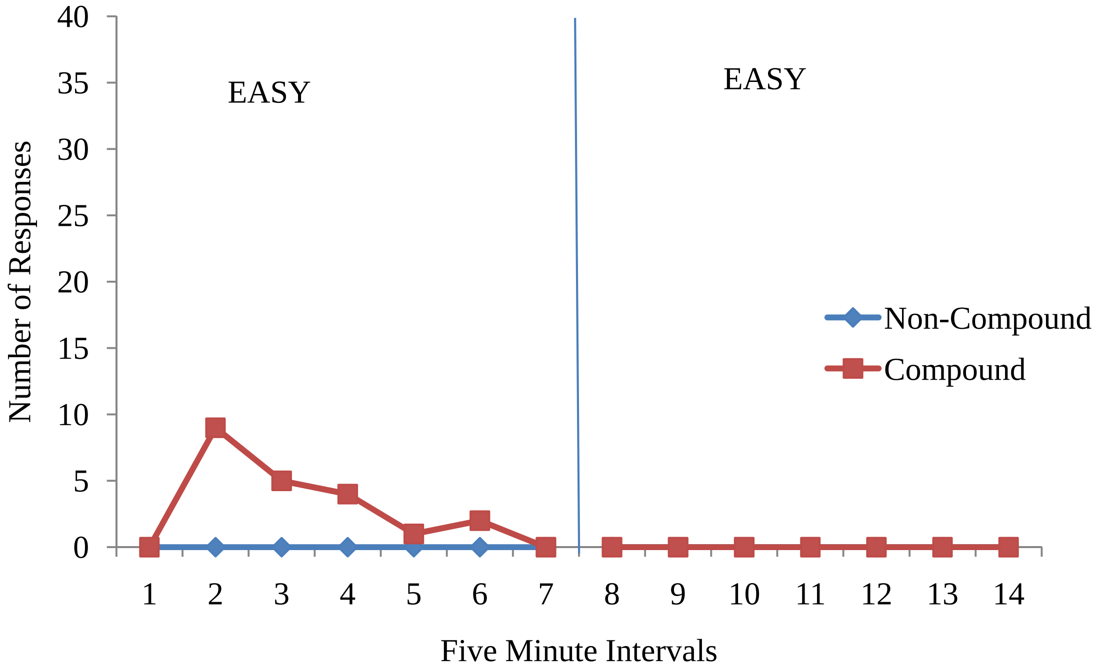




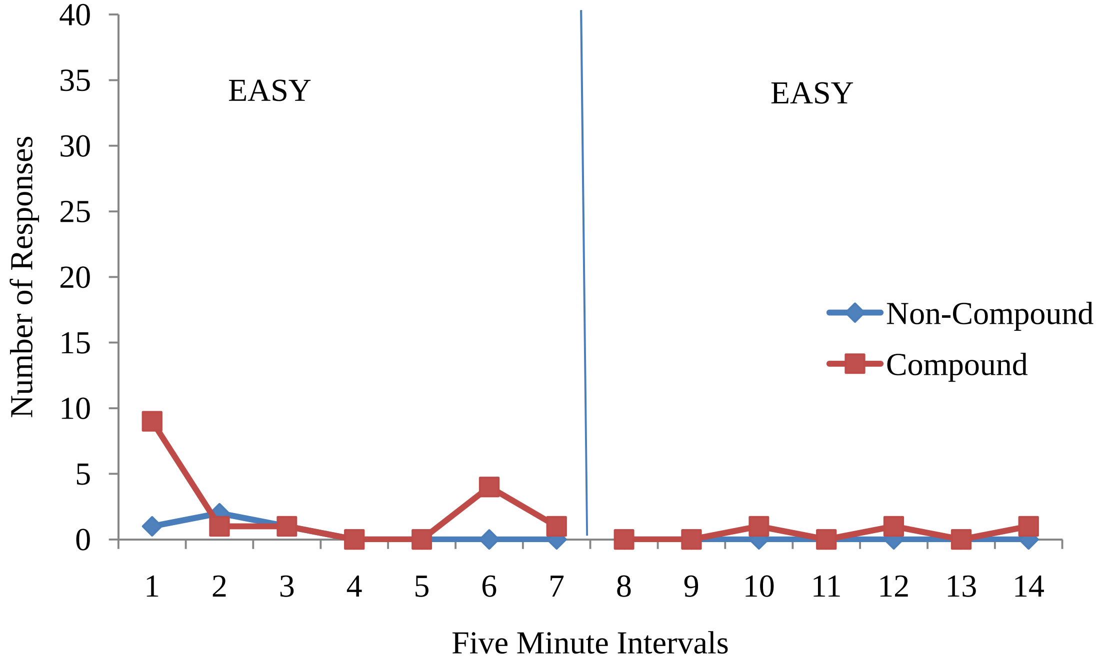
P9809 False Positives



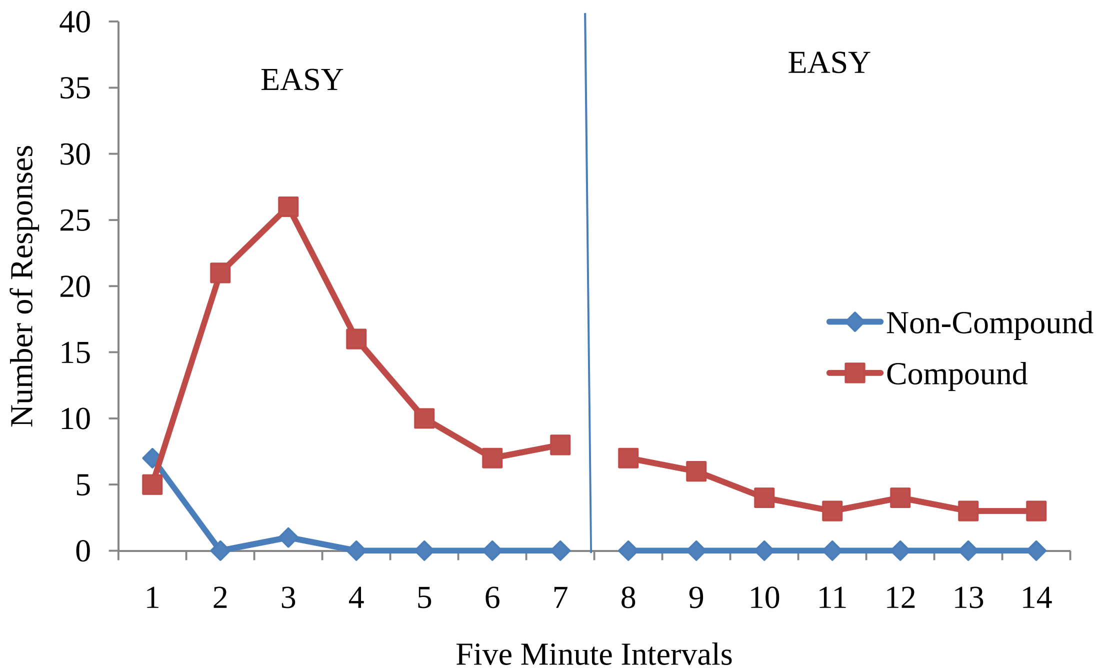
P3696 False Positives

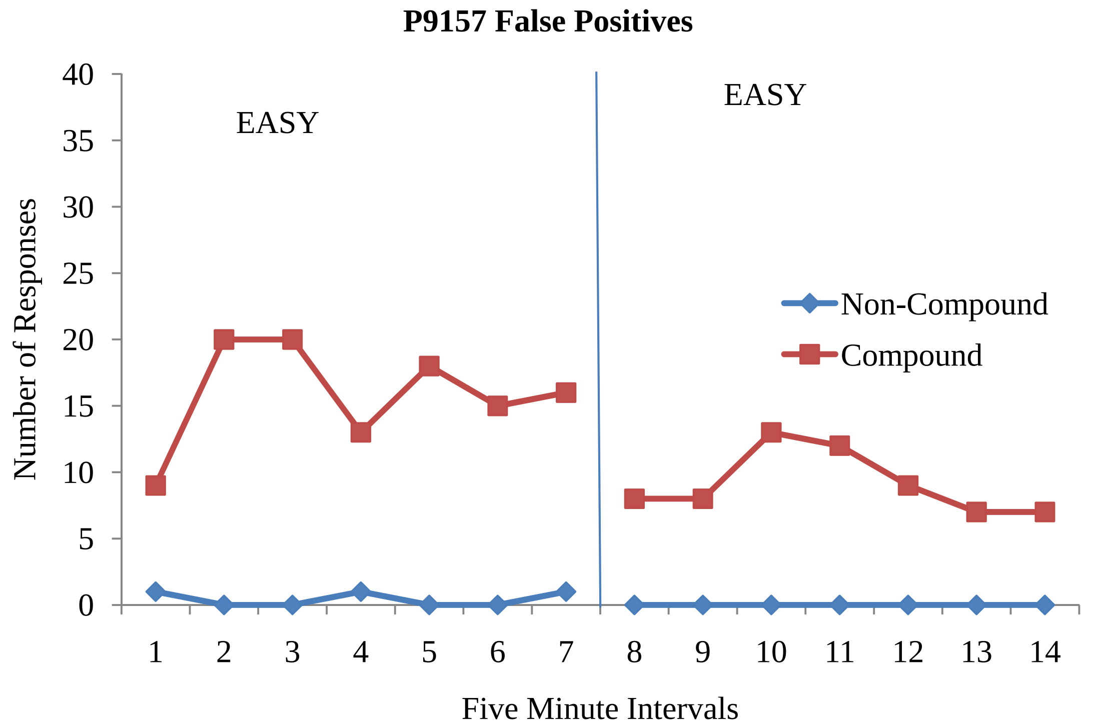


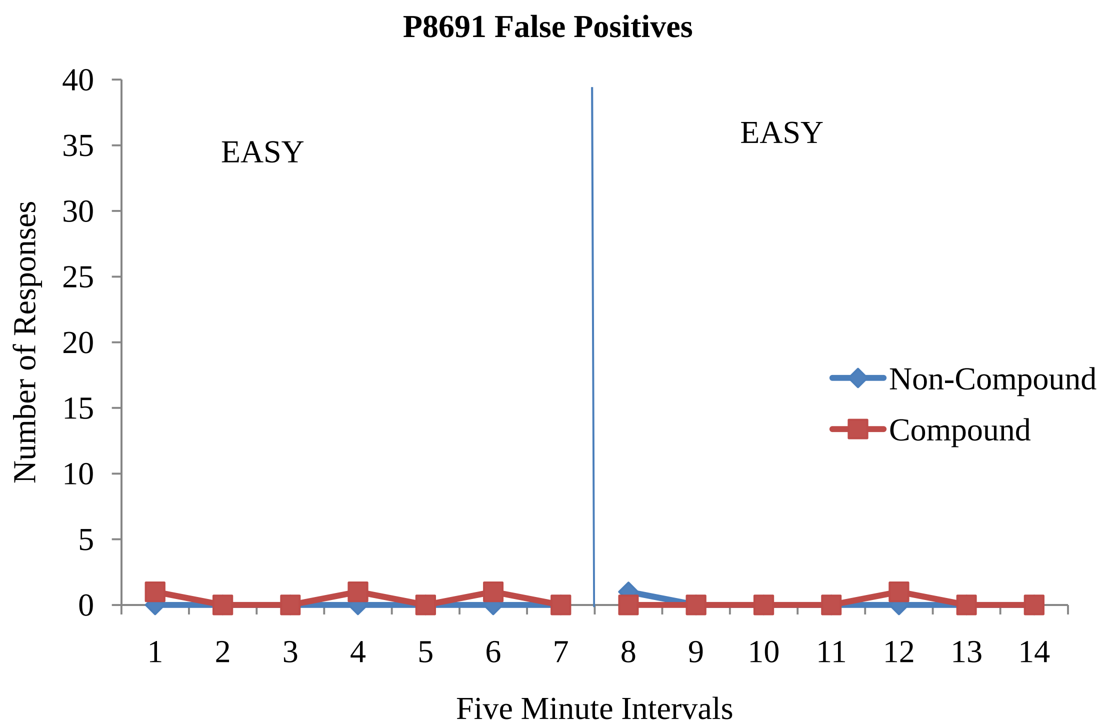
P5293 False Positives



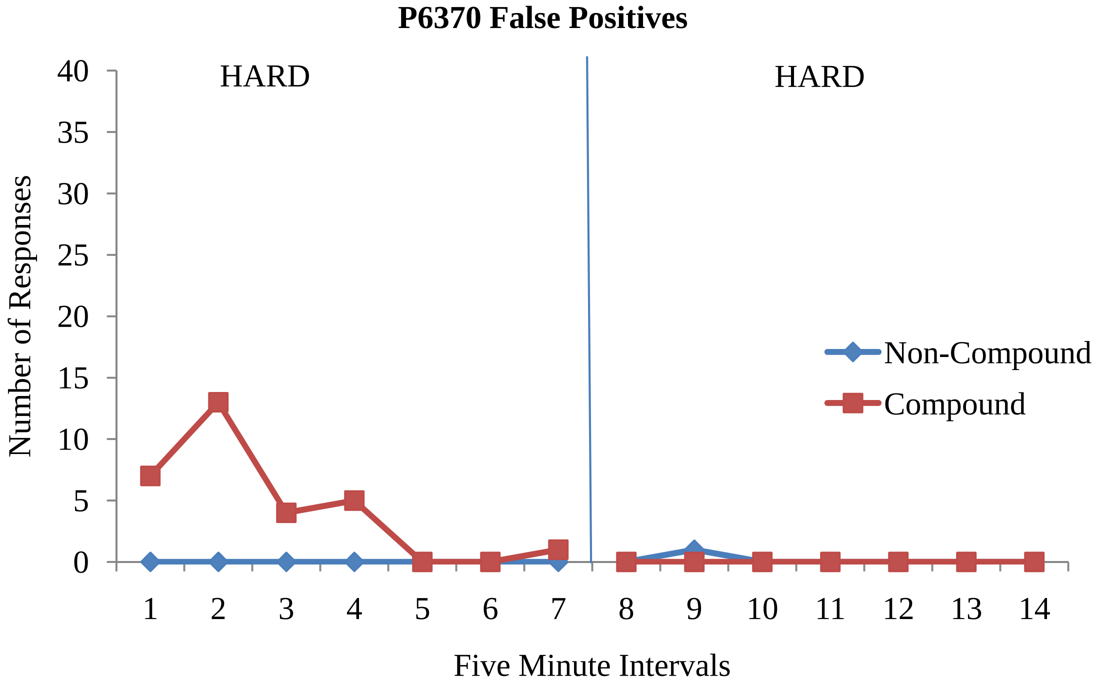
P0256 False Positives

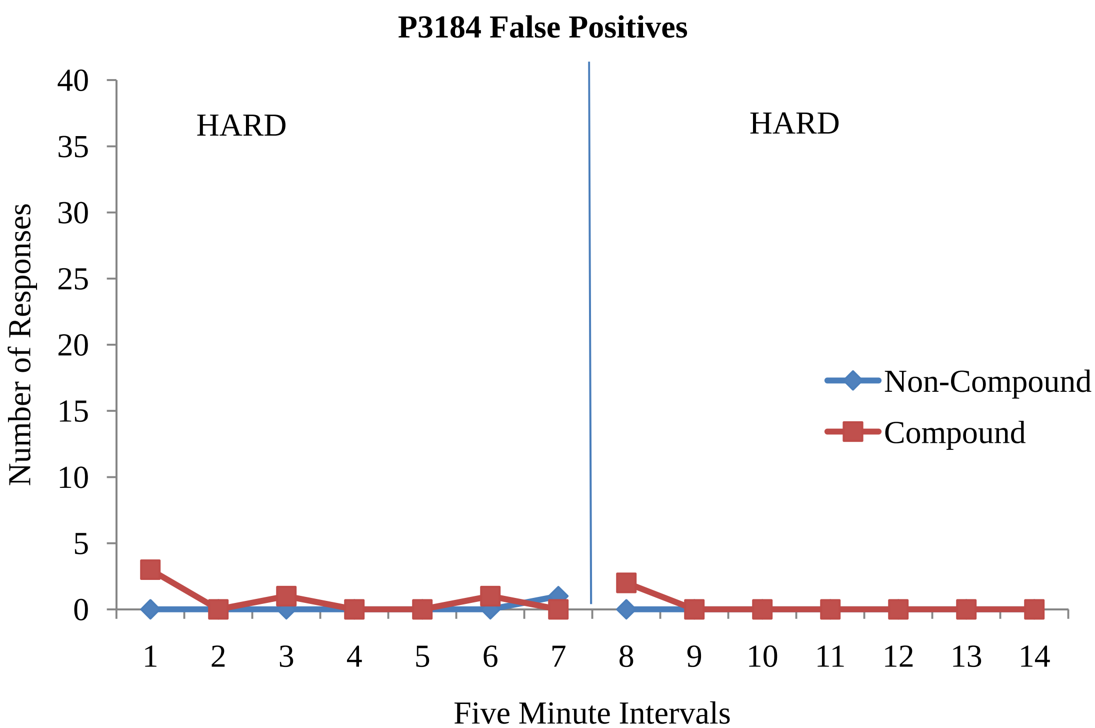



P9157 False Positives
40
35
30
25
20
15
10
5
0
Number of Responses
EASY
EASY
Non-Compound
Compound
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Five Minute Intervals

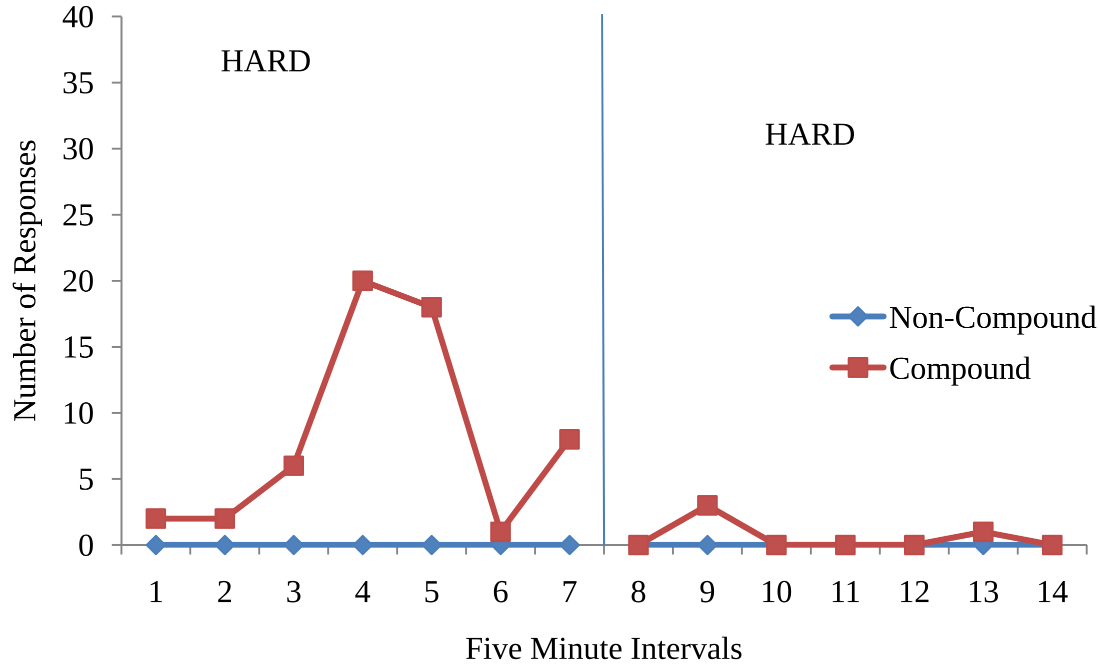

P8691 False Positives
40
35
30
25
20
15
10
5
0
Number of Responses
EASY
EASY
Non-Compound
Compound
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Five Minute Intervals

APPENDIX B4
HARD-HARD INDIVIDUAL FALSE POSITIVES

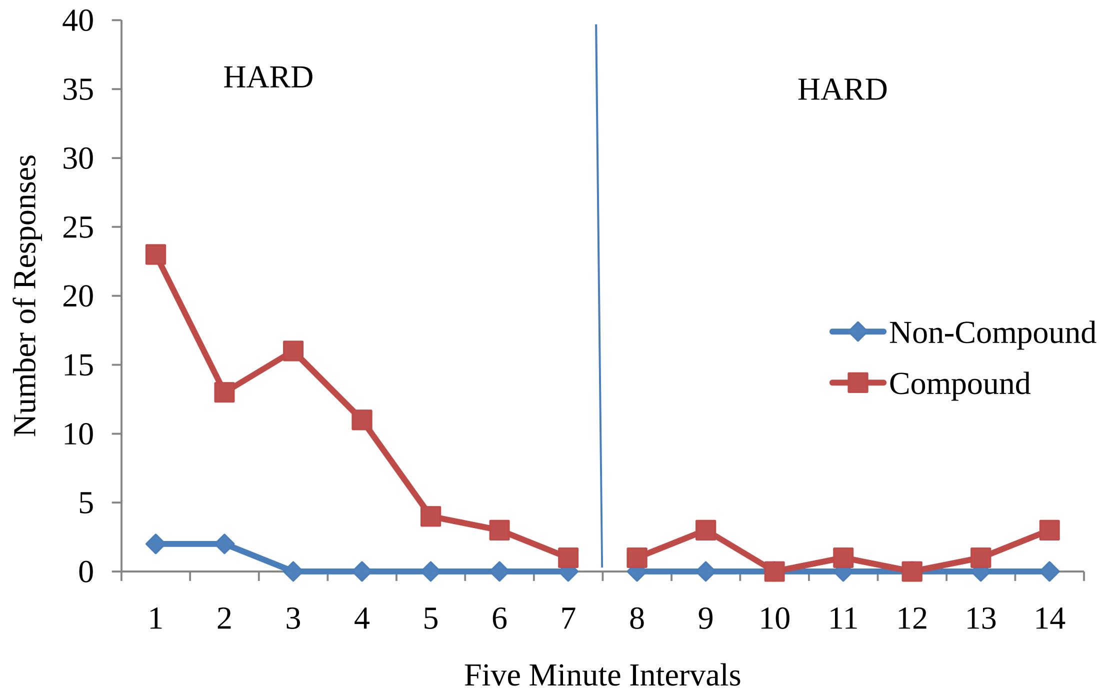


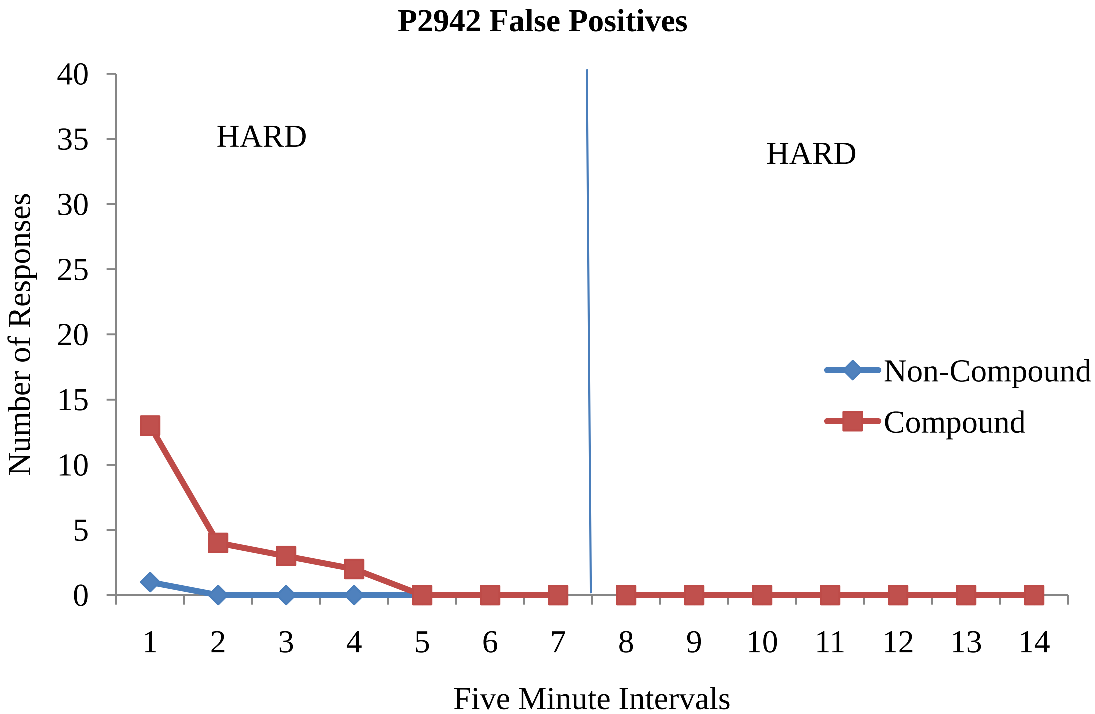


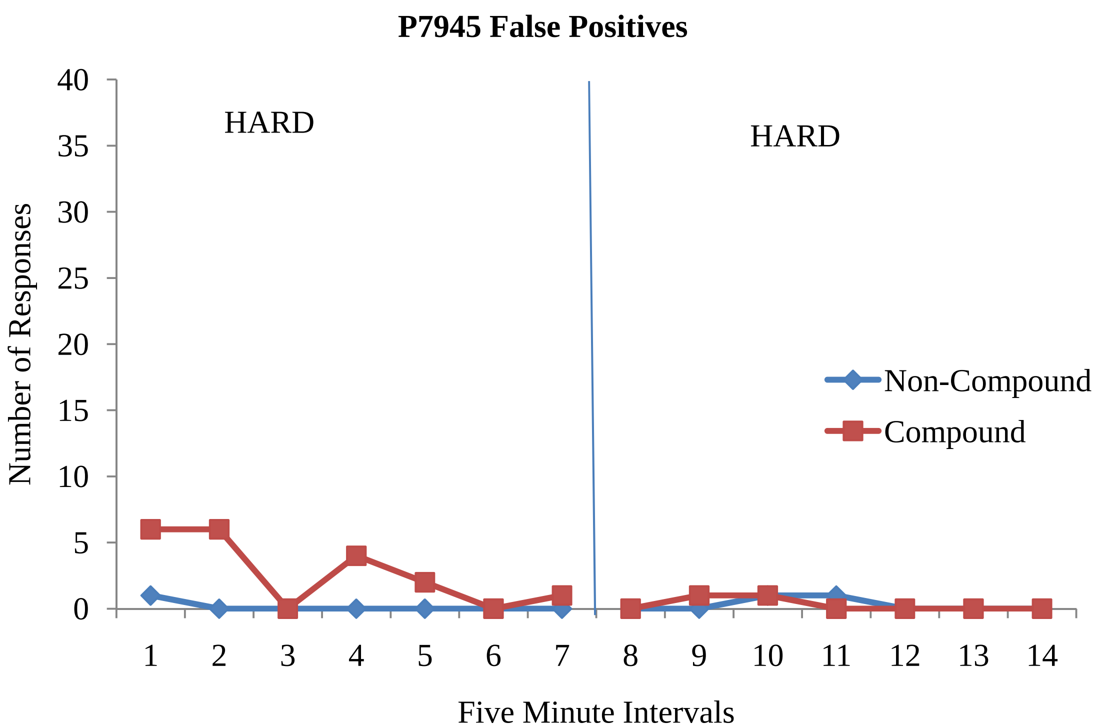
P1161 False Positives



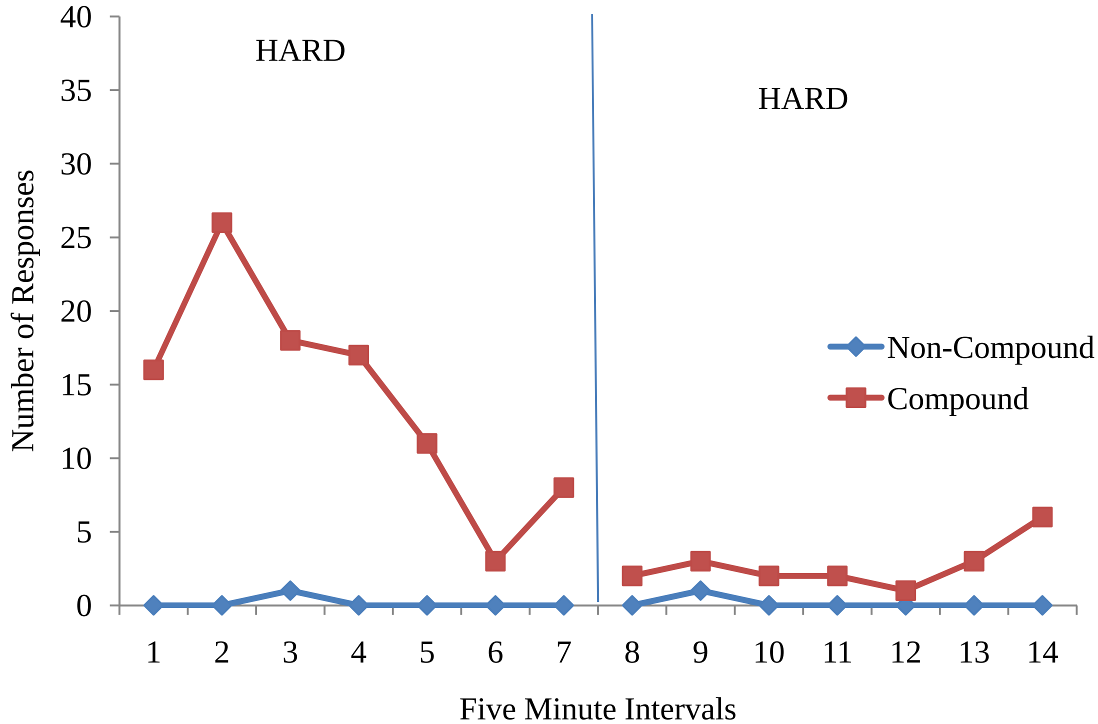
P5209 False Positives



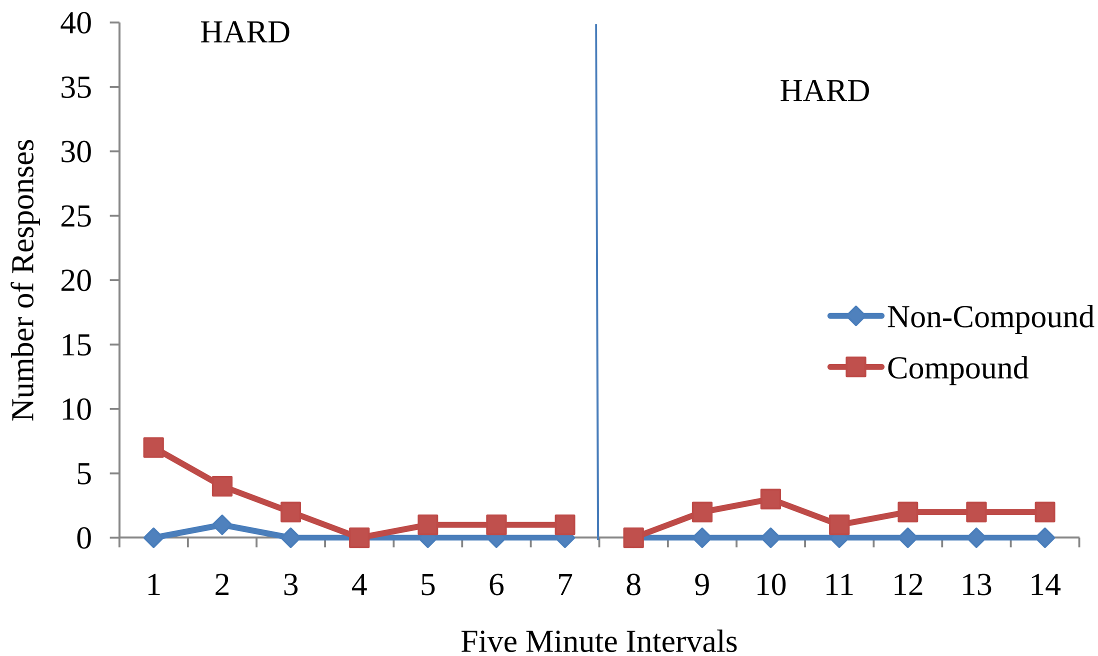

P2942 False Positives
HARD
HARD
Number of Responses
40
35
30
25
20
15
10
5
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Five Minute Intervals
Non-Compound
Compound


P7945 False Positives
HARD
HARD
Number of Responses
40
35
30
25
20
15
10
5
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Five Minute Intervals
Non-Compound
Compound

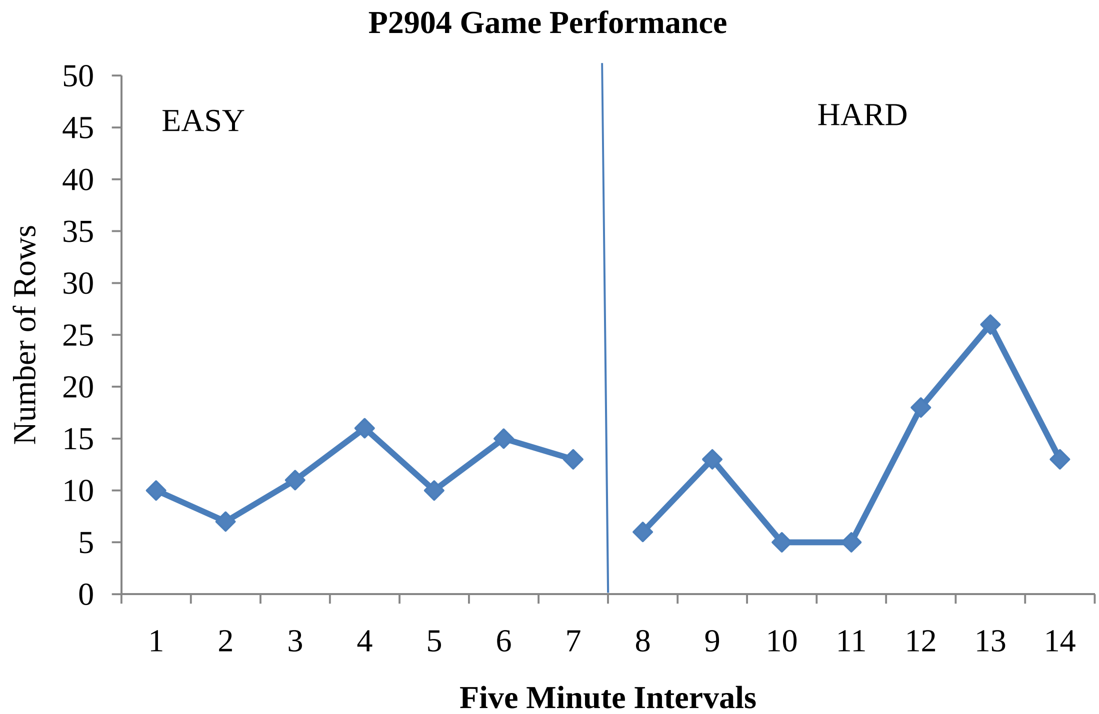
P9121 False Positives

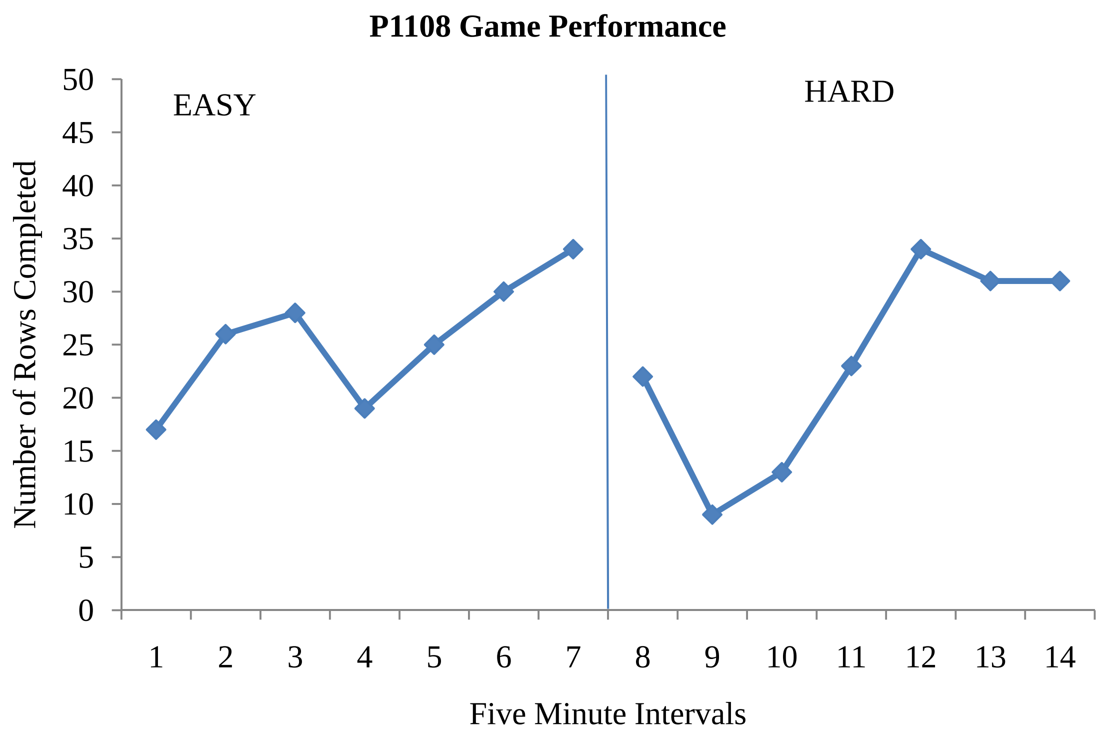


P9633 False Positives

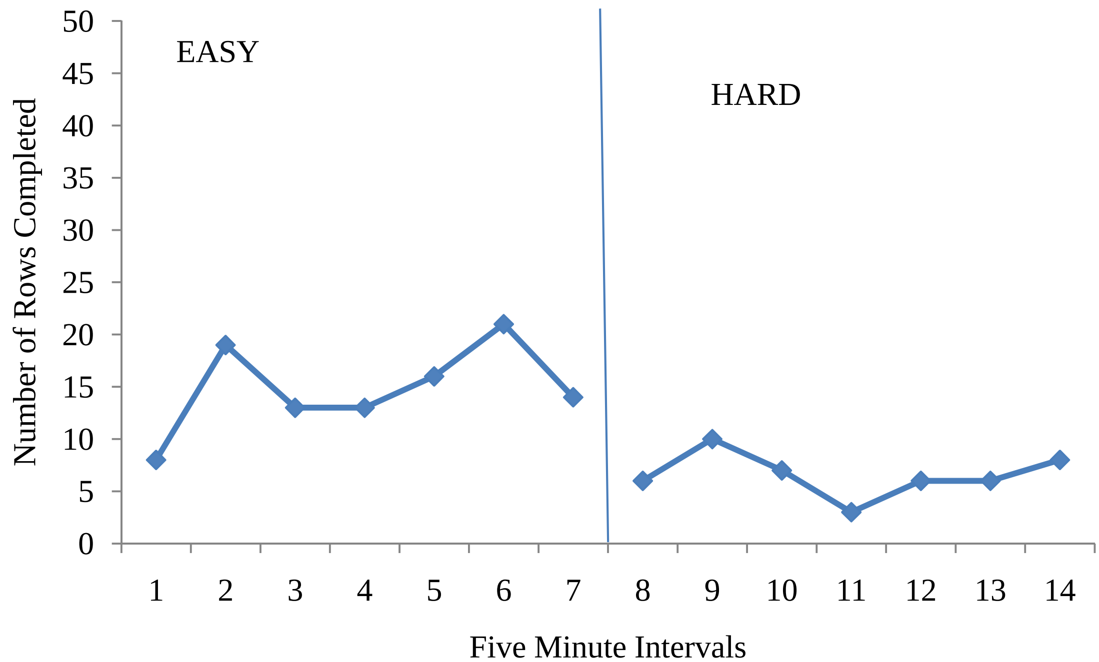


APPENDIX C1
EASY-HARD INDIVIDUAL GAME PERFORMANCE

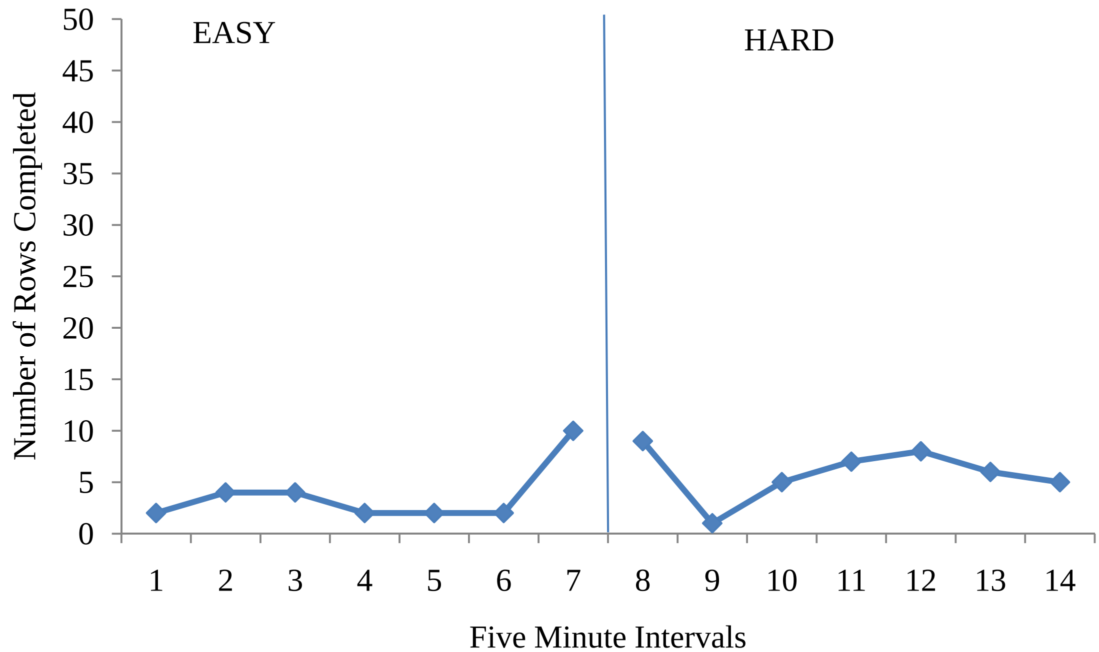




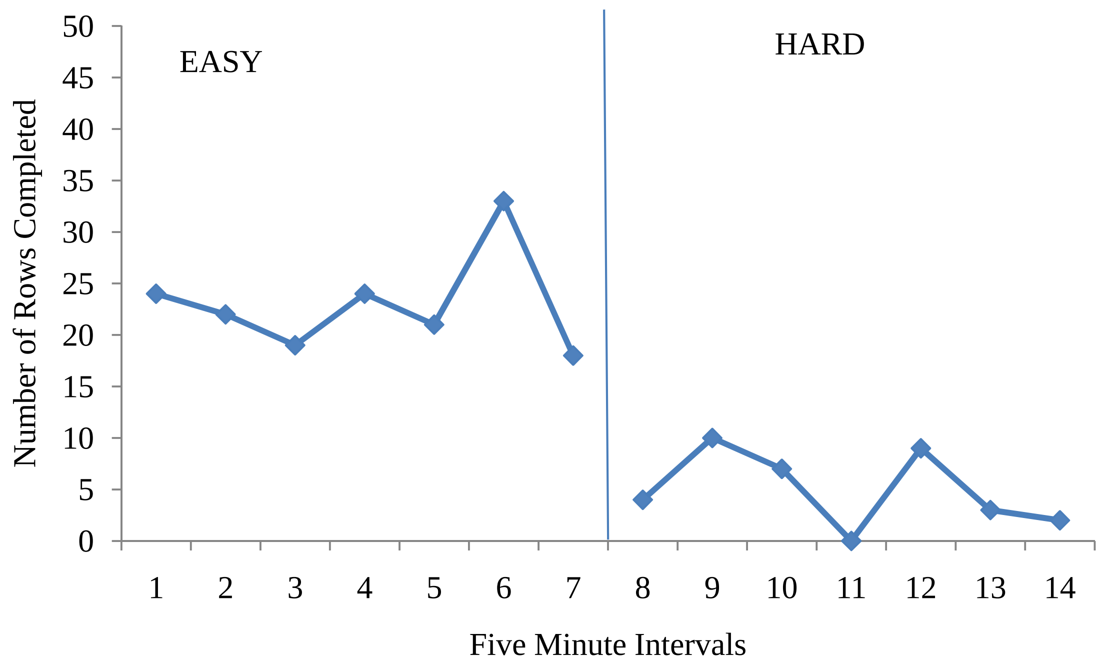
P6675 Game Performance



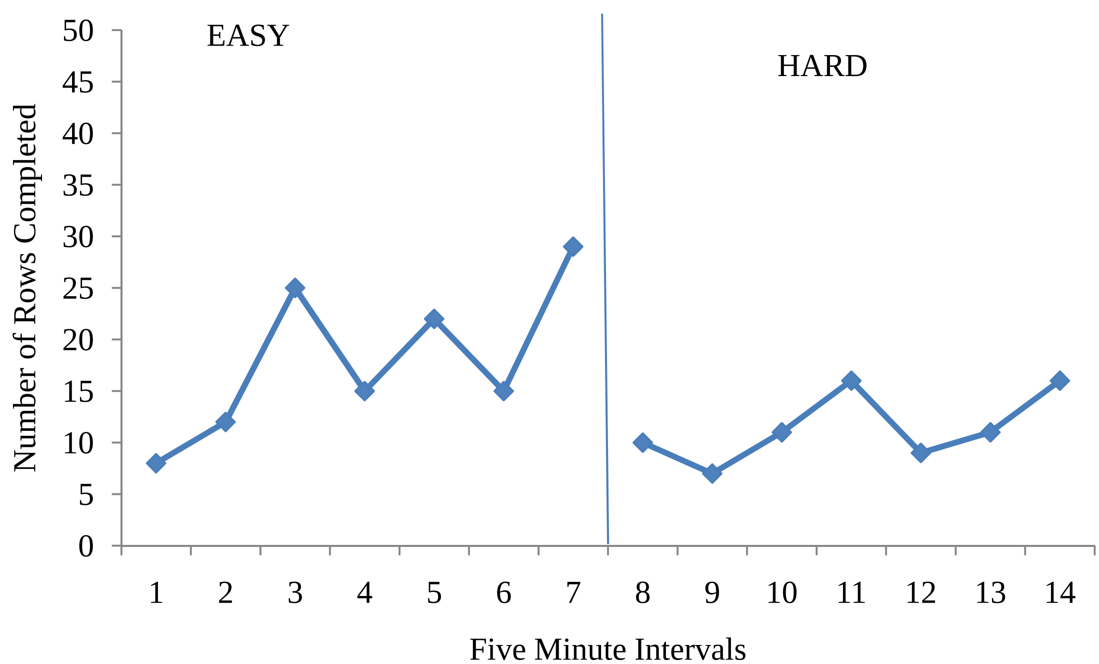
P5832 Game Performance



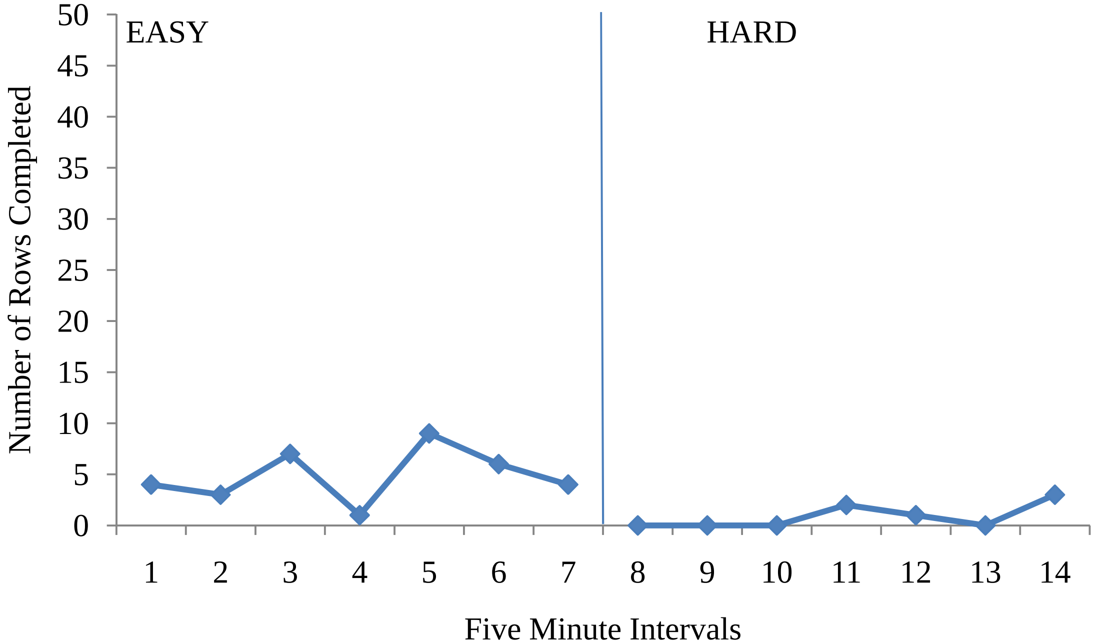
P0549 Game Performance



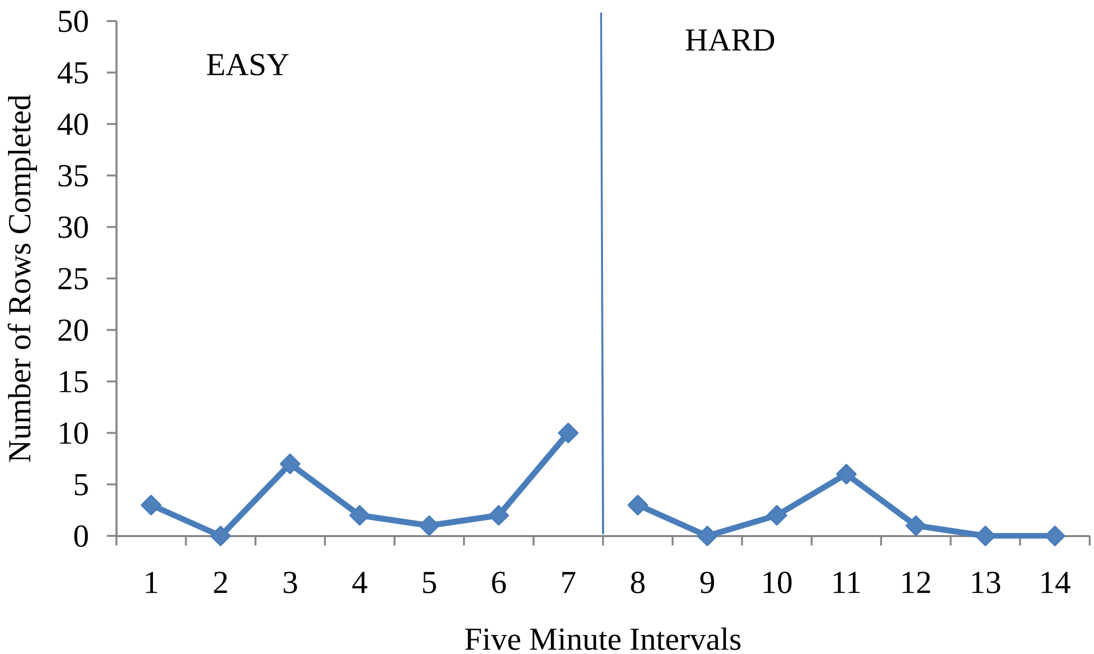
P9771 Game Performance



P0469 Game Performance

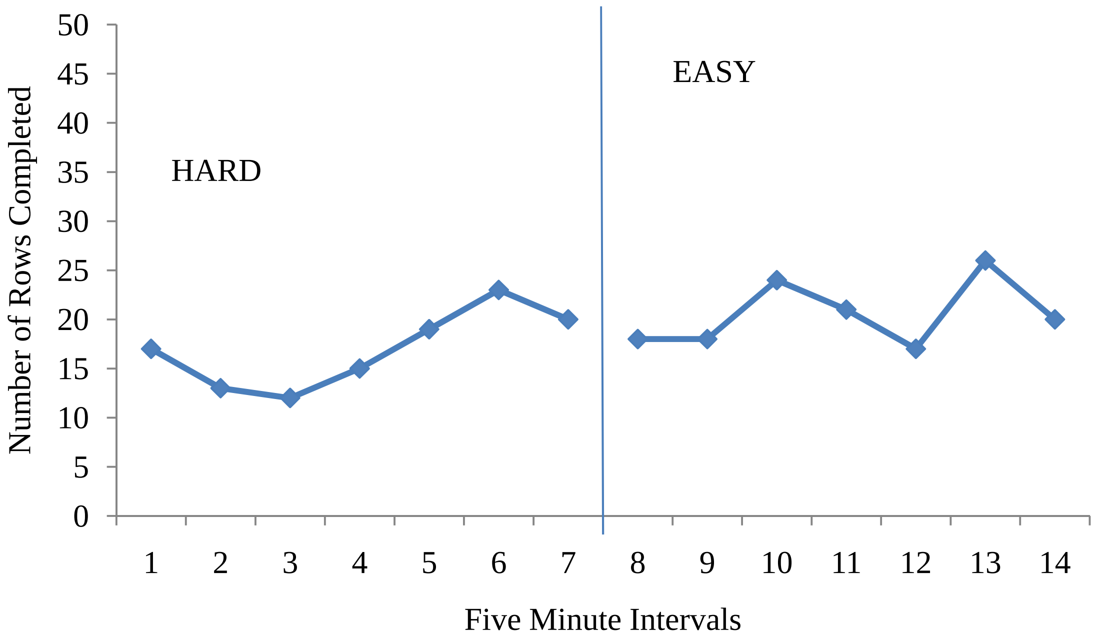


P2482 Game Performance

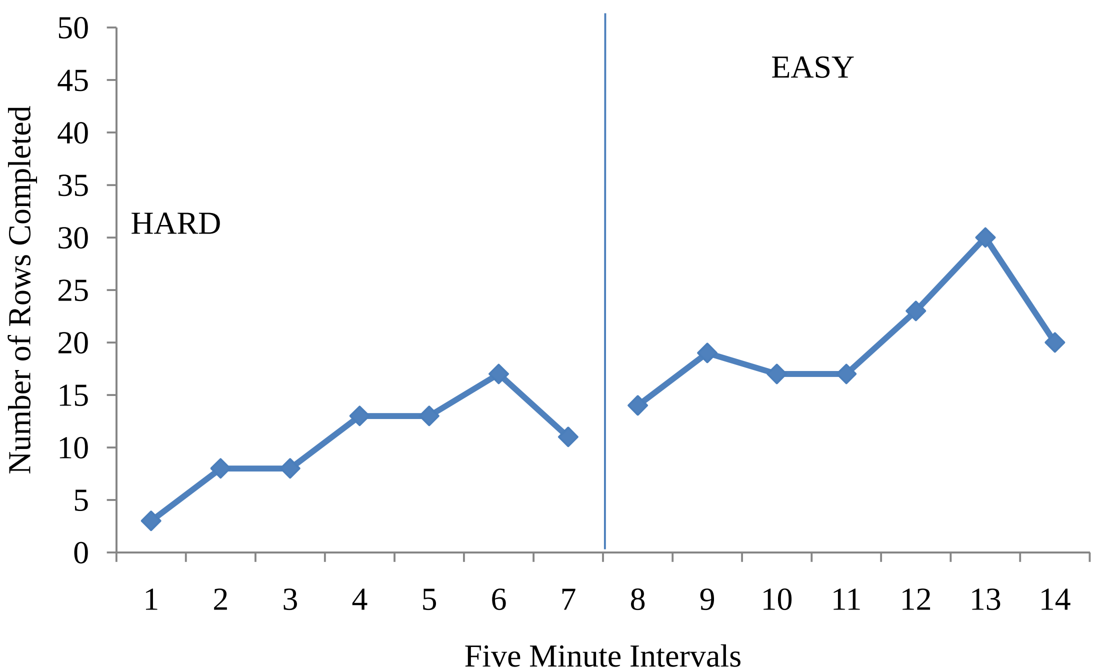


APPENDIX C2
HARD-EASY INDIVIDUAL GAME PERFORMANCE

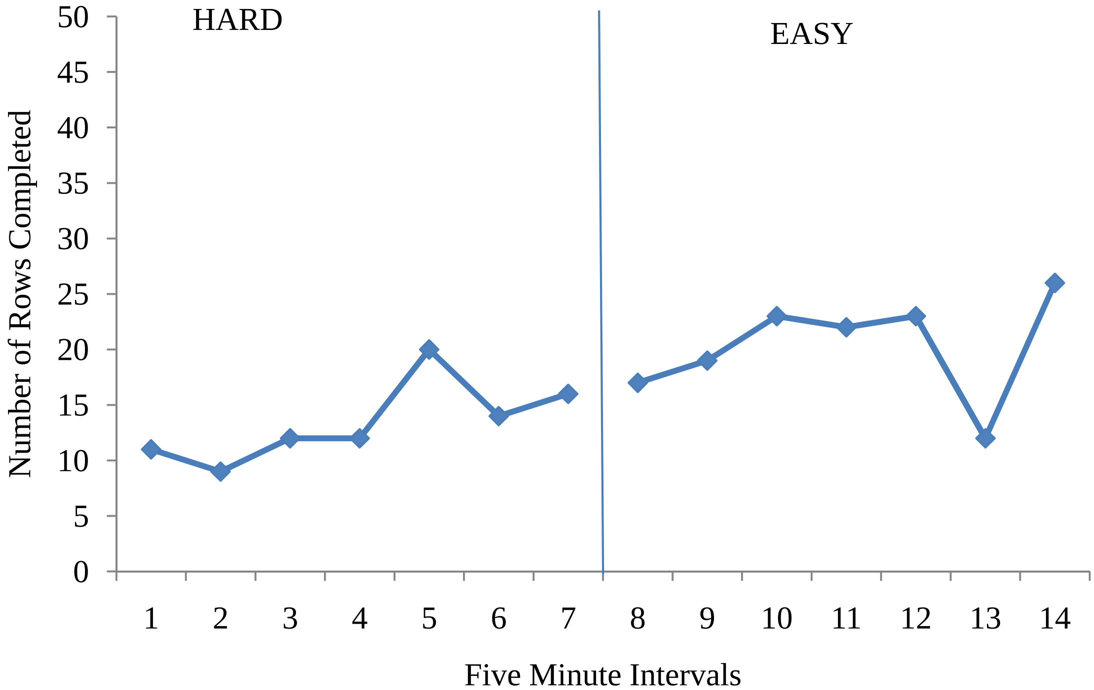
P9491 Game Performance



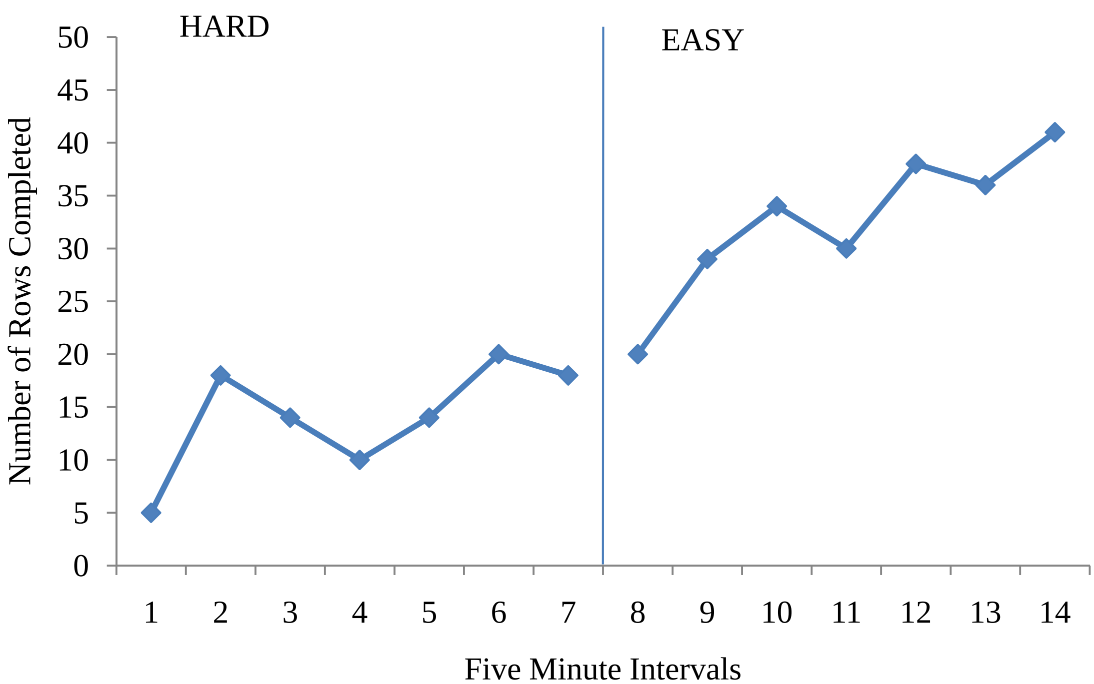
P9372 Game Performance



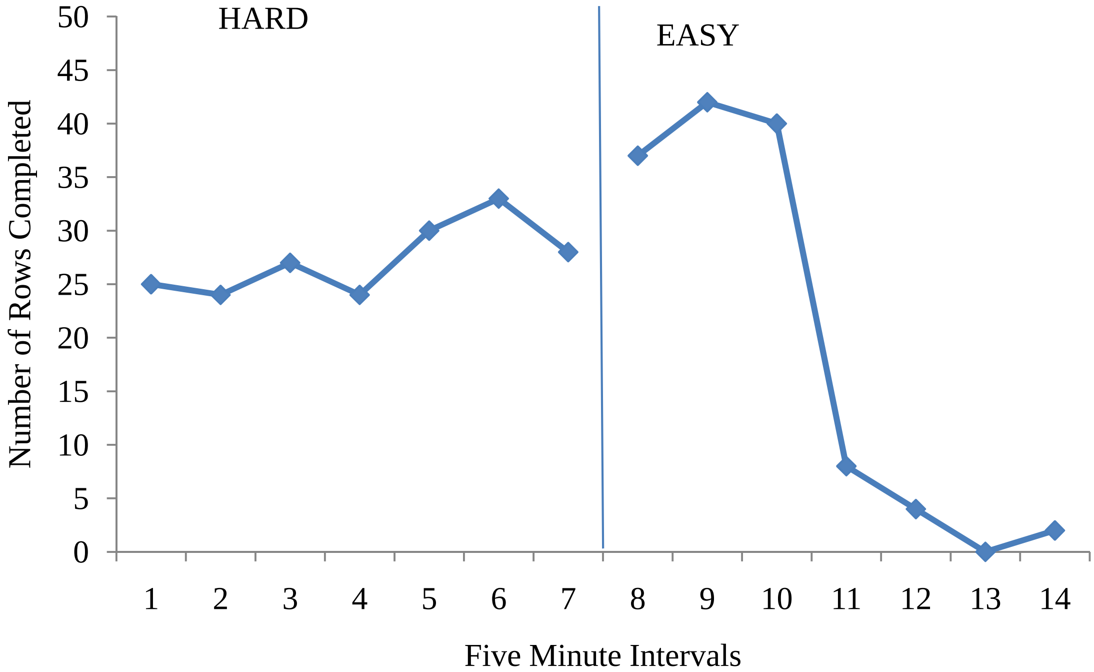
P2288 Game Performance



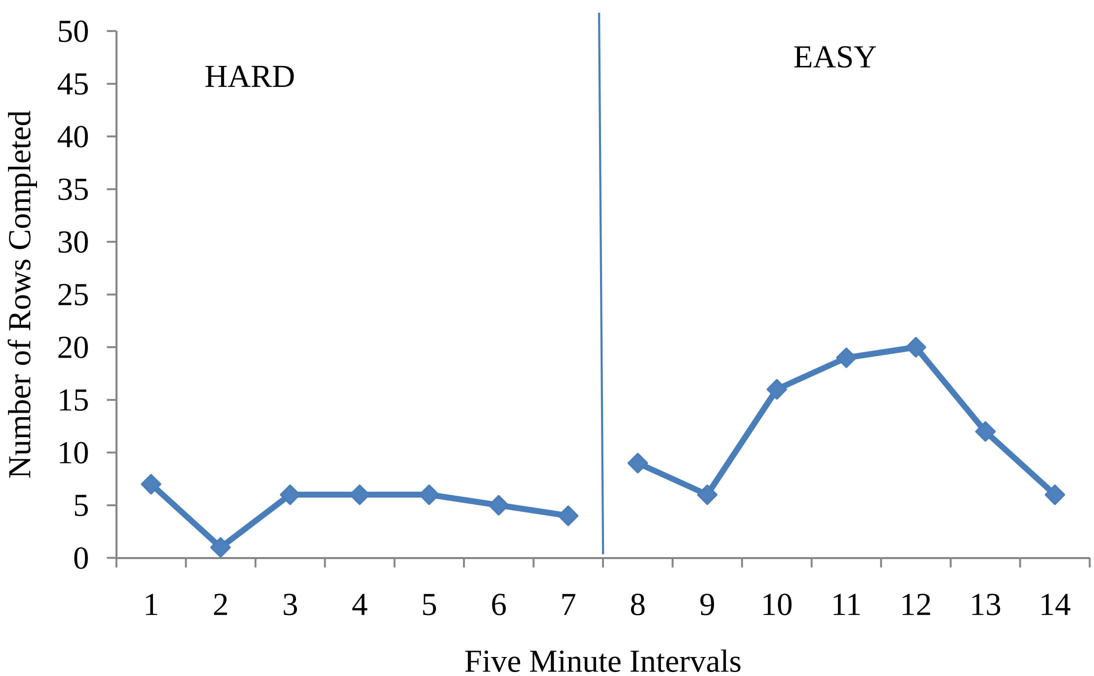
P7110 Game Performance



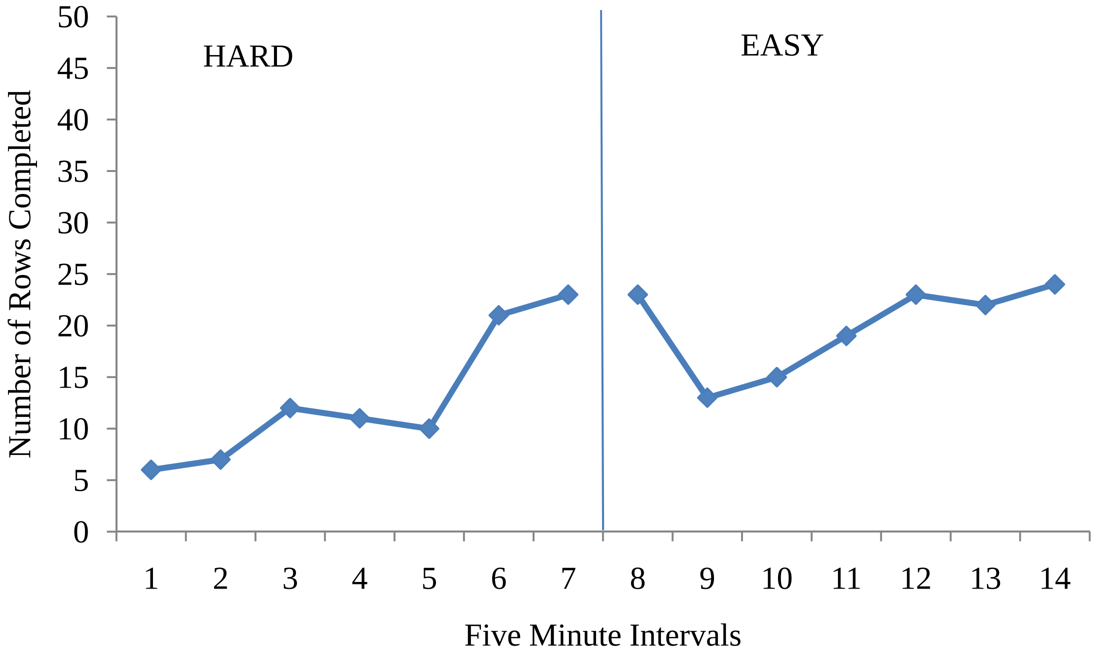
P7393 Game Performance



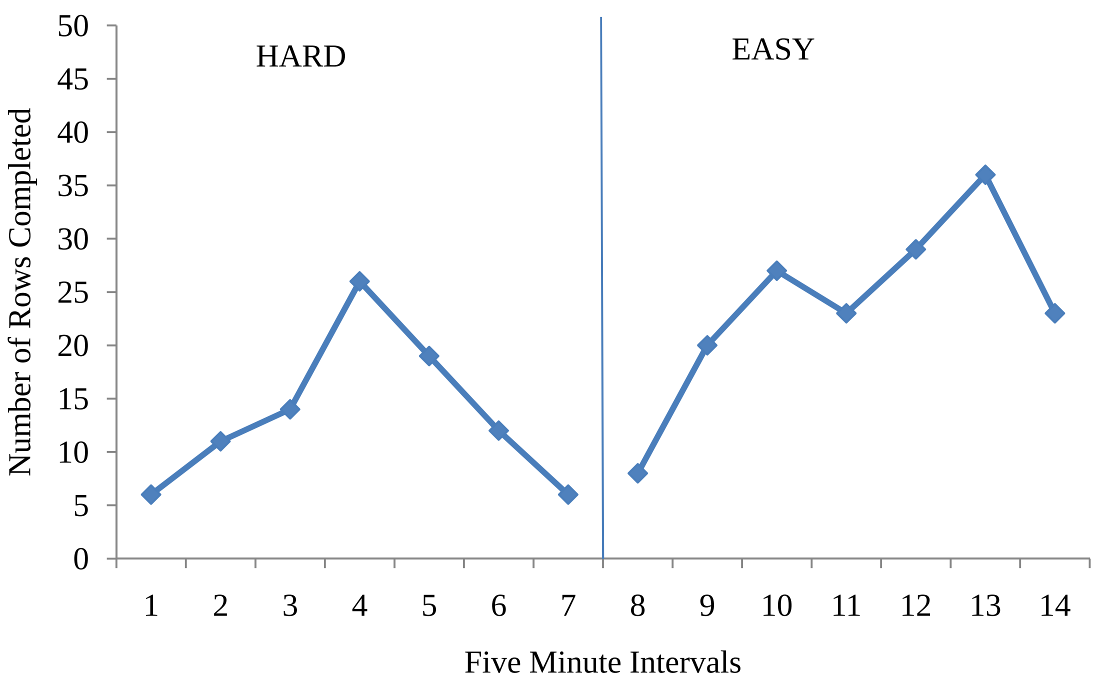
P7594 Game Performance



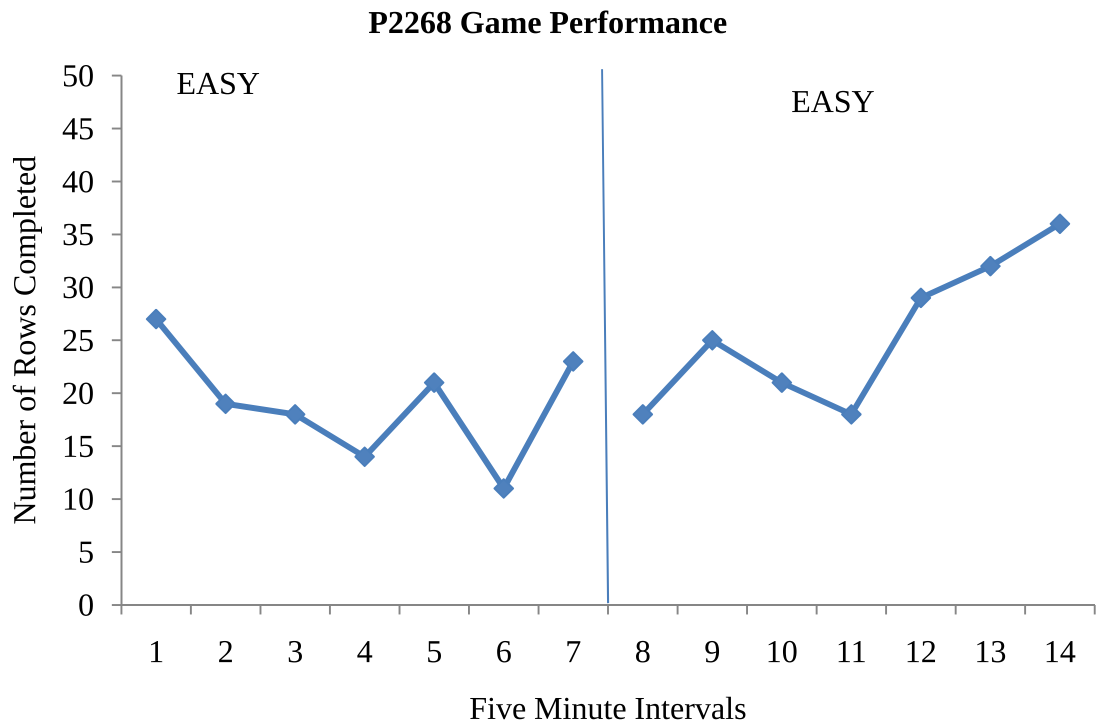
P3831 Game Performance

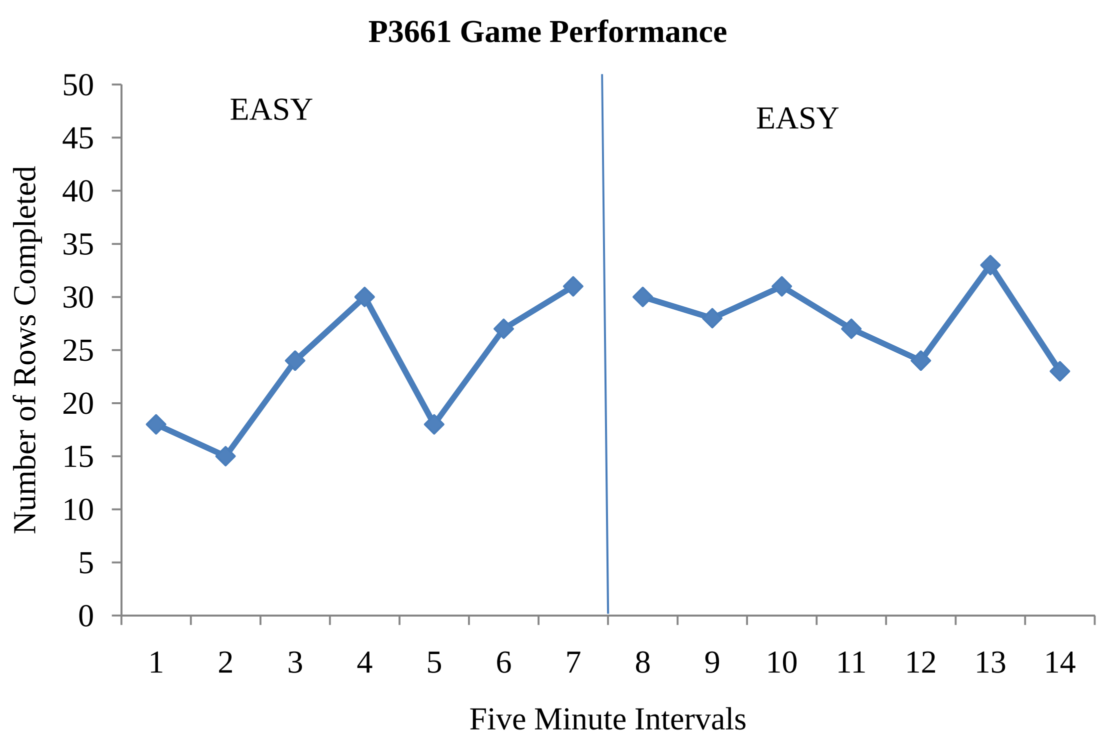


P3108 Game Performance

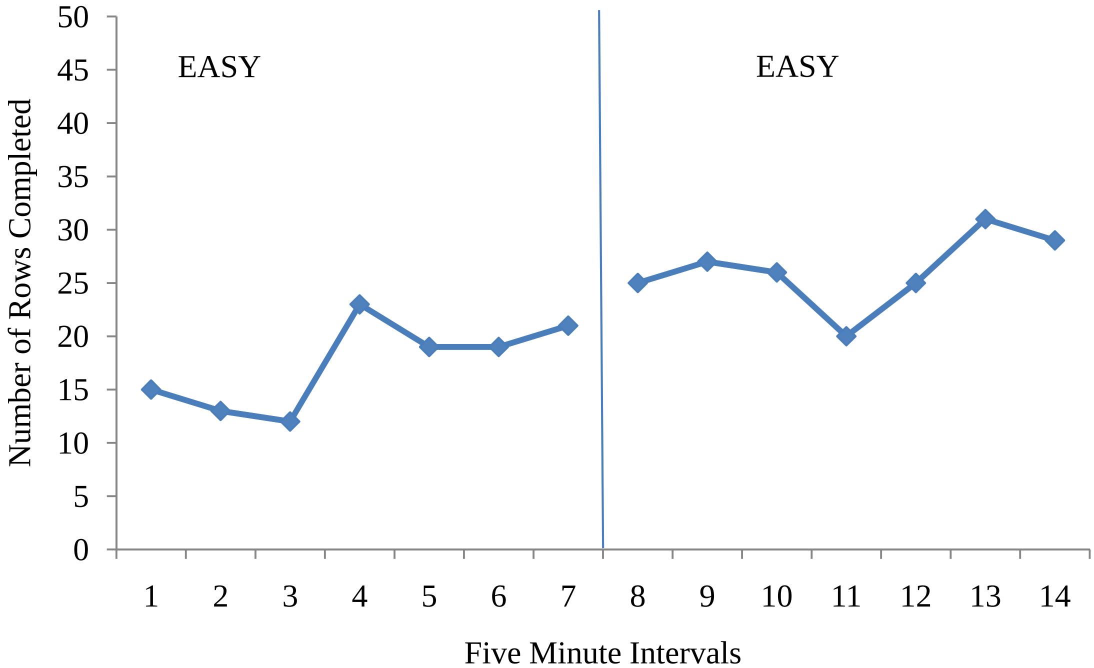


APPENDIX C3
EASY-EASY INDIVIDUAL GAME PERFORMANCE

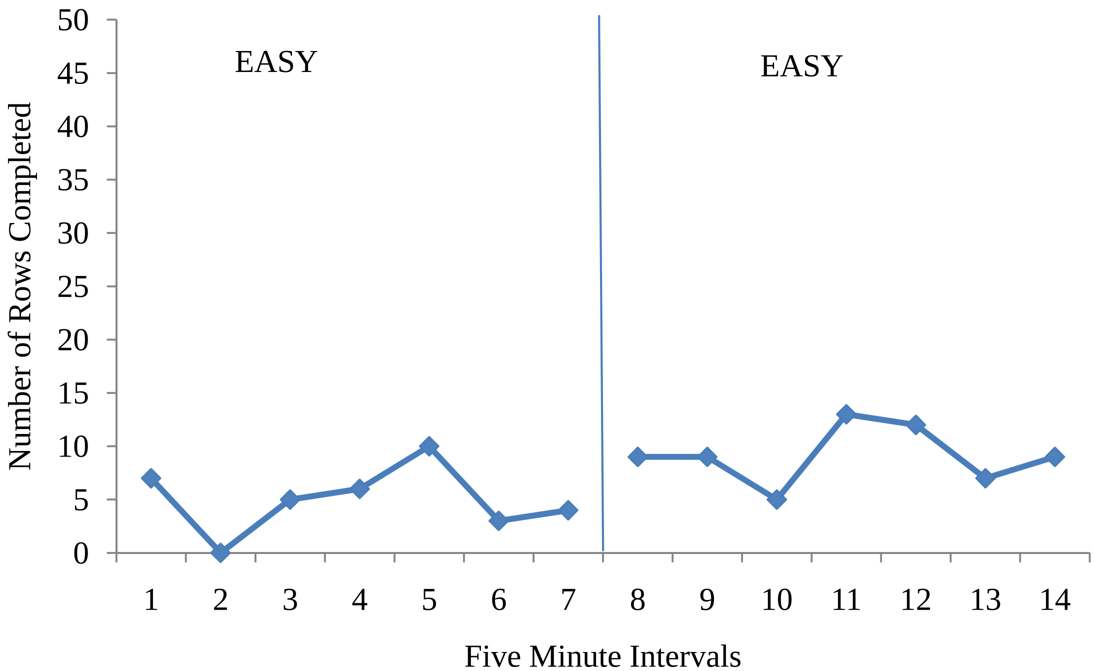


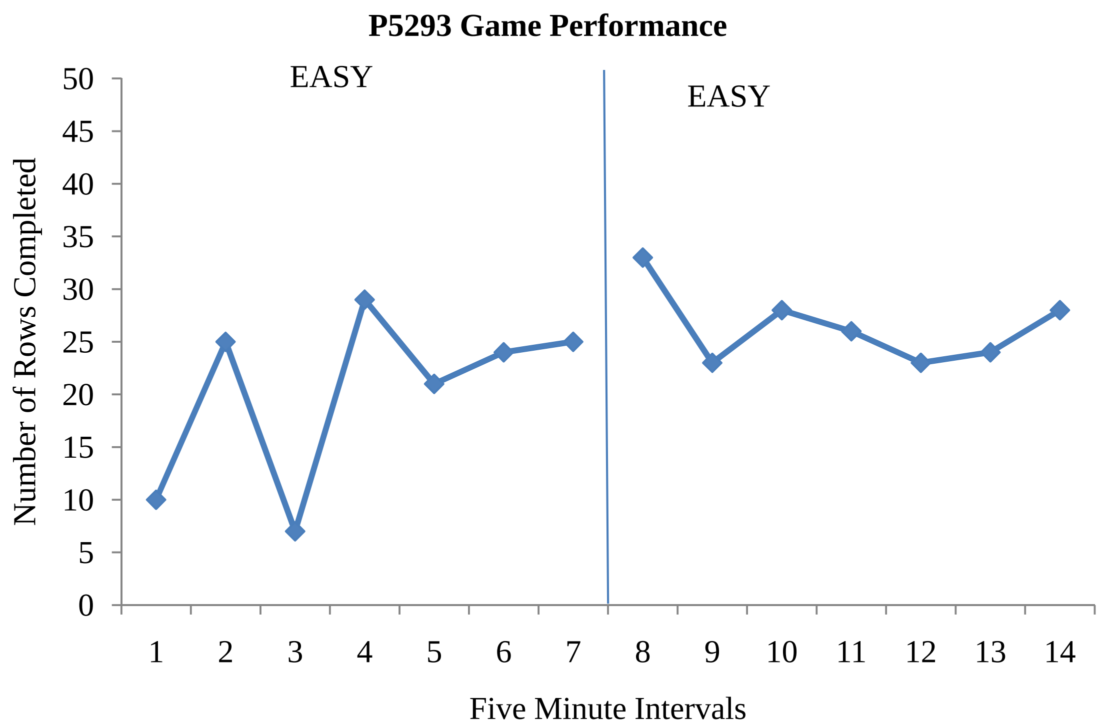


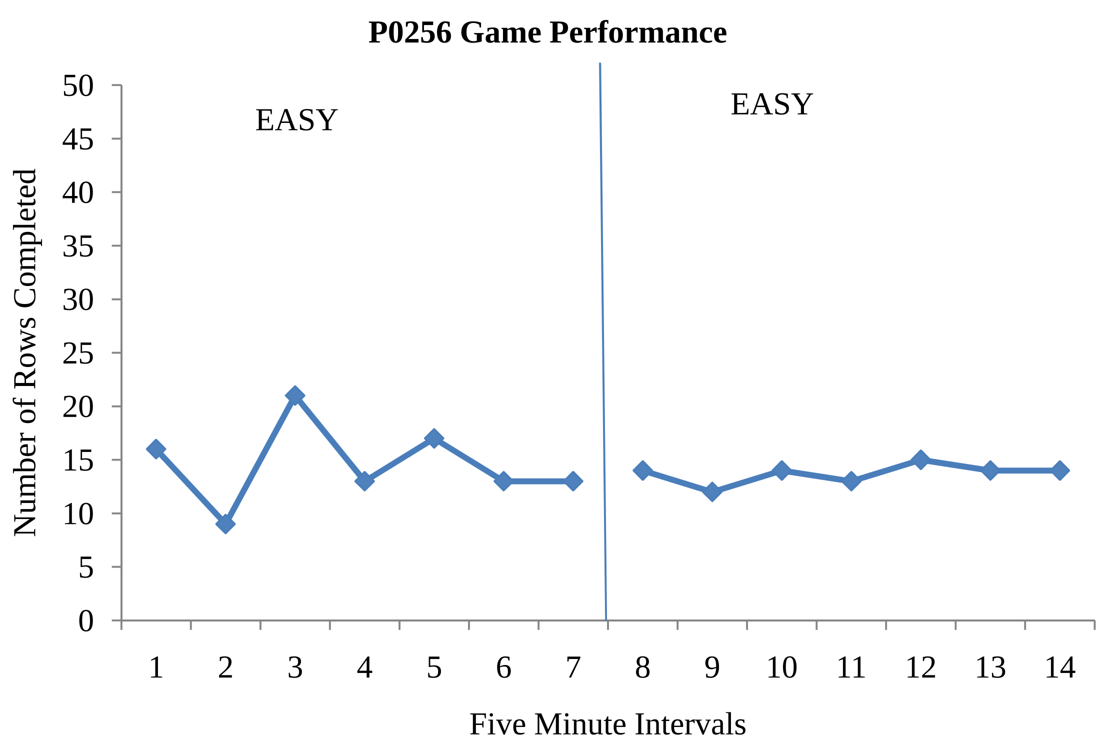
P9809 Game Performance



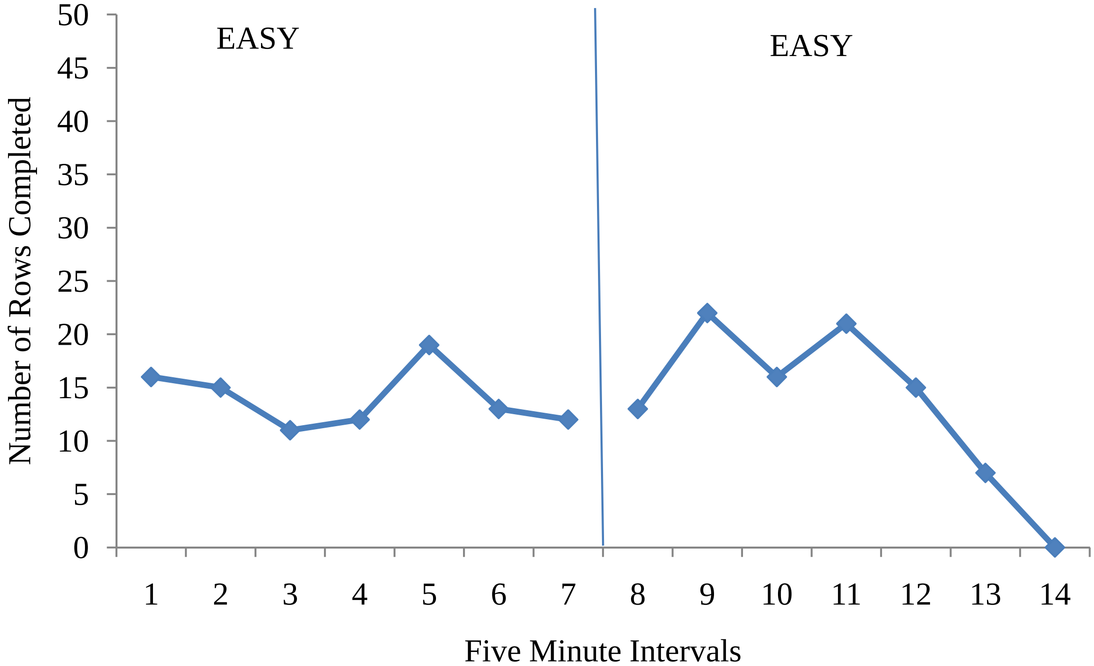
P3696 Game Performance



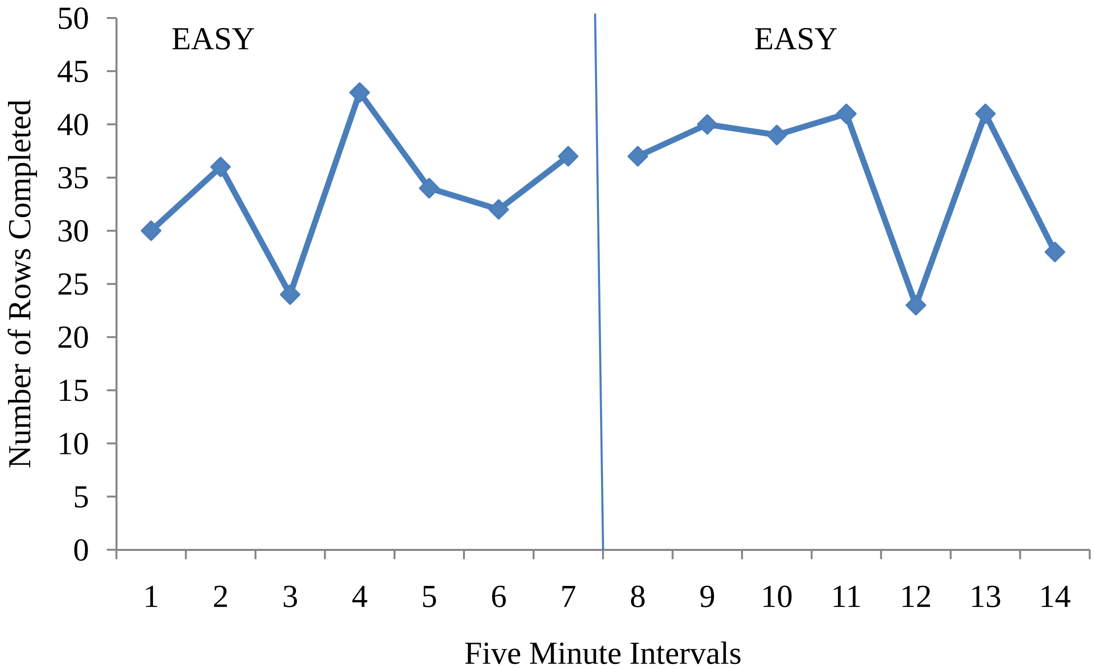

P5293 Game Performance
EASY
EASY
Number of Rows Completed
0
5
10
15
20
25
30
35
40
45
50
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Five Minute Intervals


P0256 Game Performance
EASY
EASY
Number of Rows Completed
0
5
10
15
20
25
30
35
40
45
50
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Five Minute Intervals

P9157 Game Performance

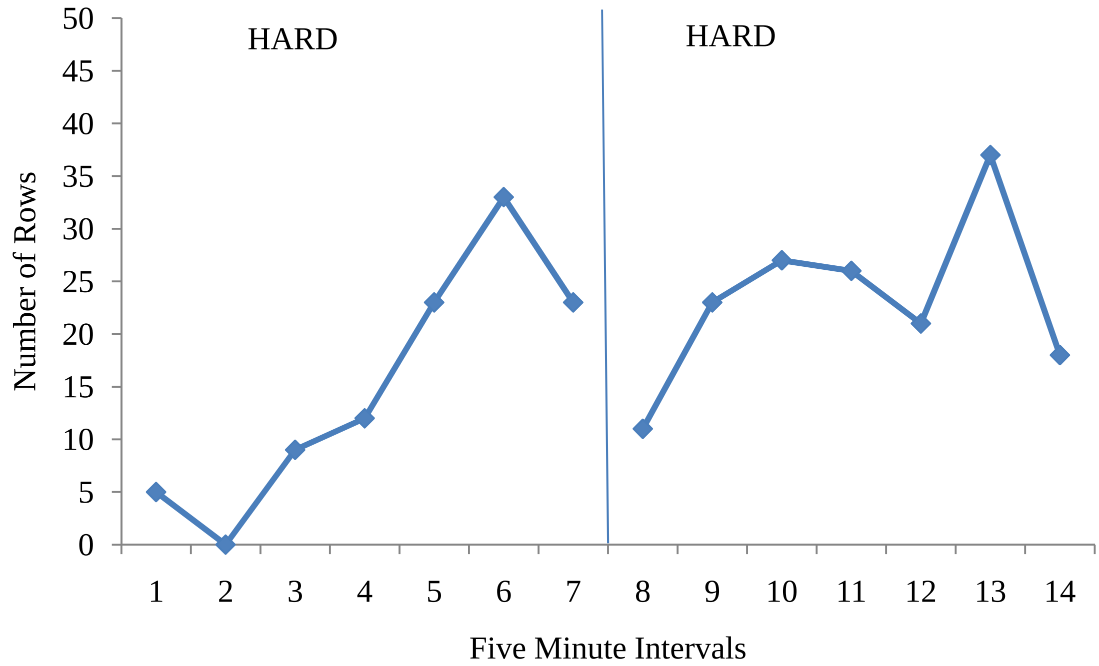


P8691 Game Performance

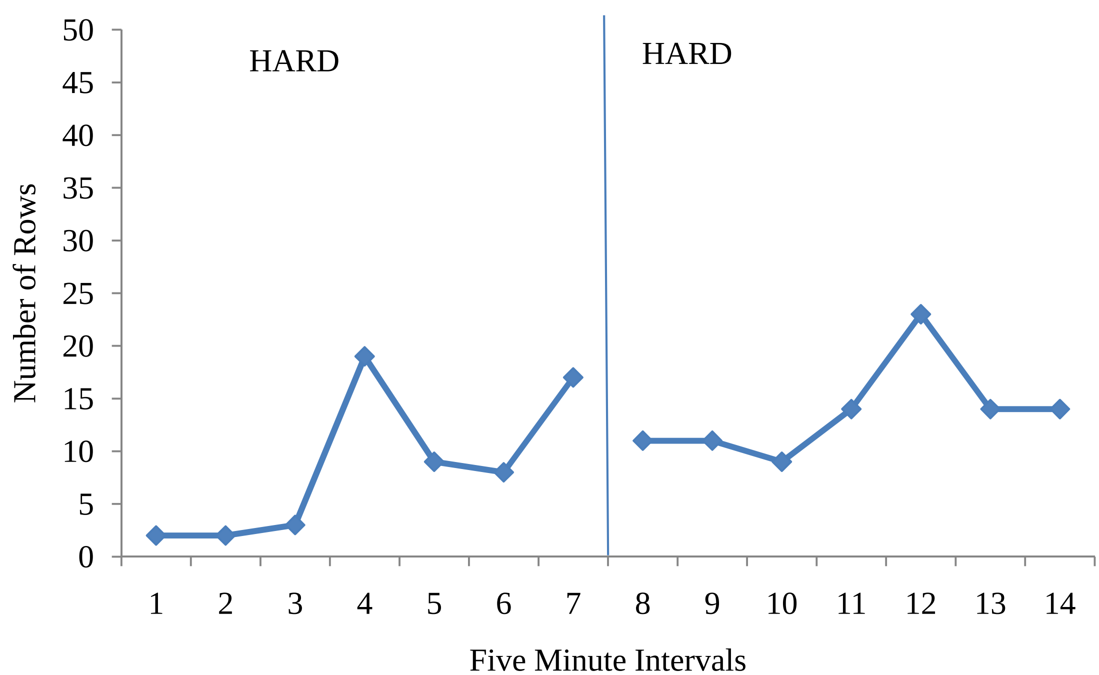


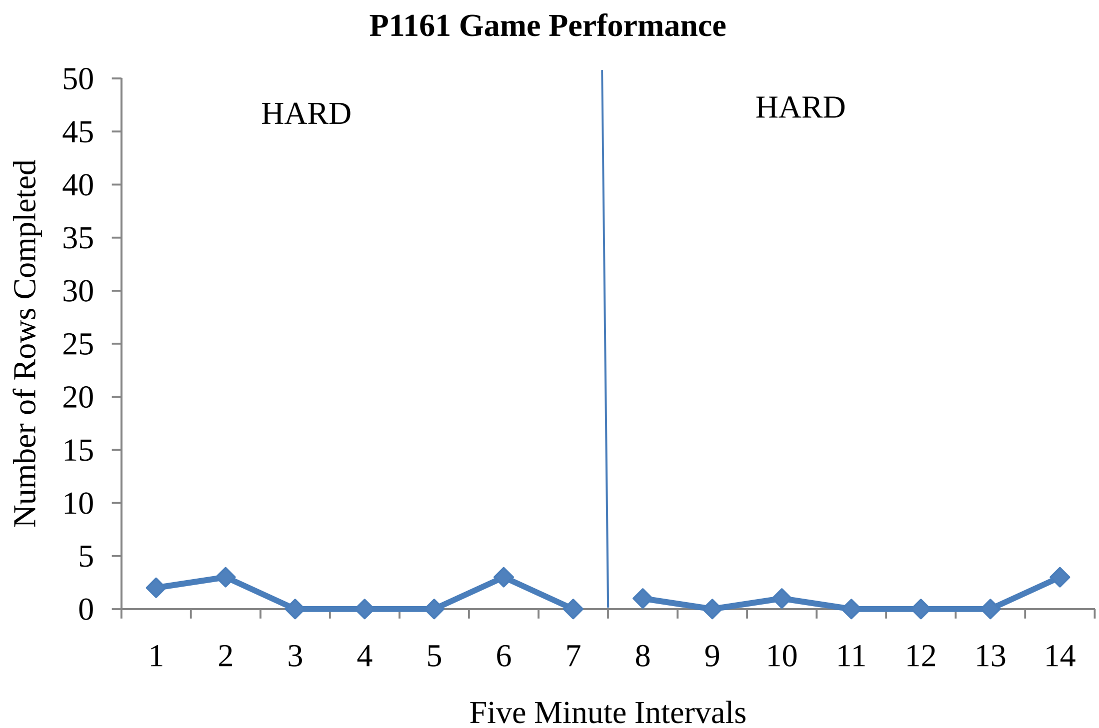
APPENDIX C4
HARD-HARD INDIVIDUAL GAME PERFORMANCE

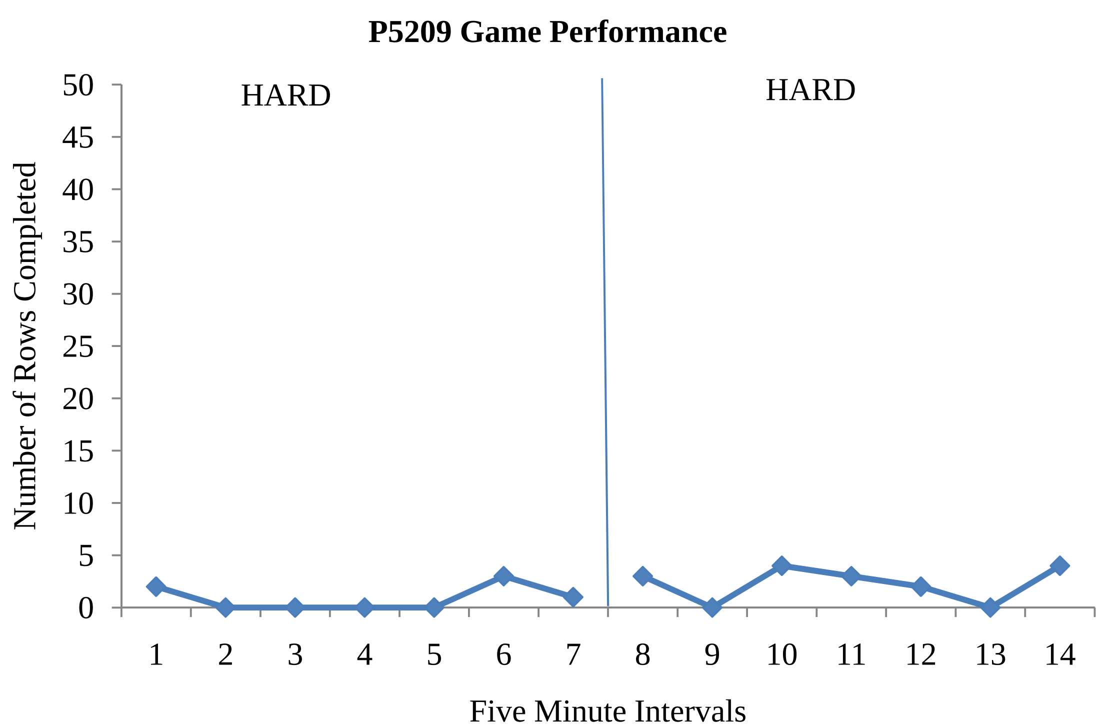
P6370 Game Performance



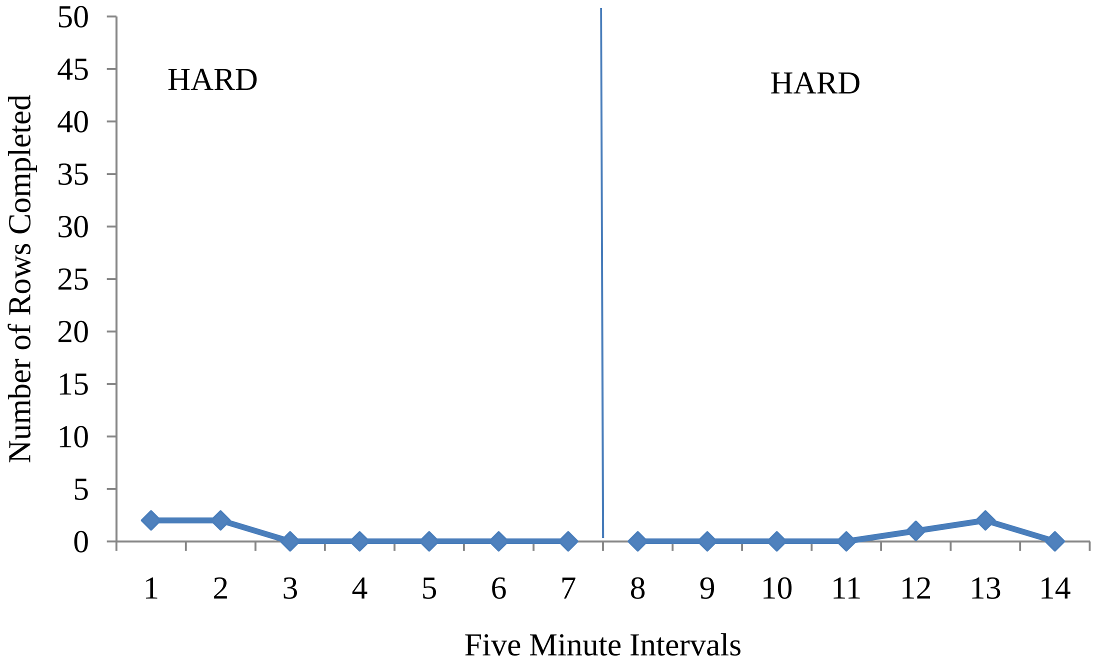
P3184 Game Performance



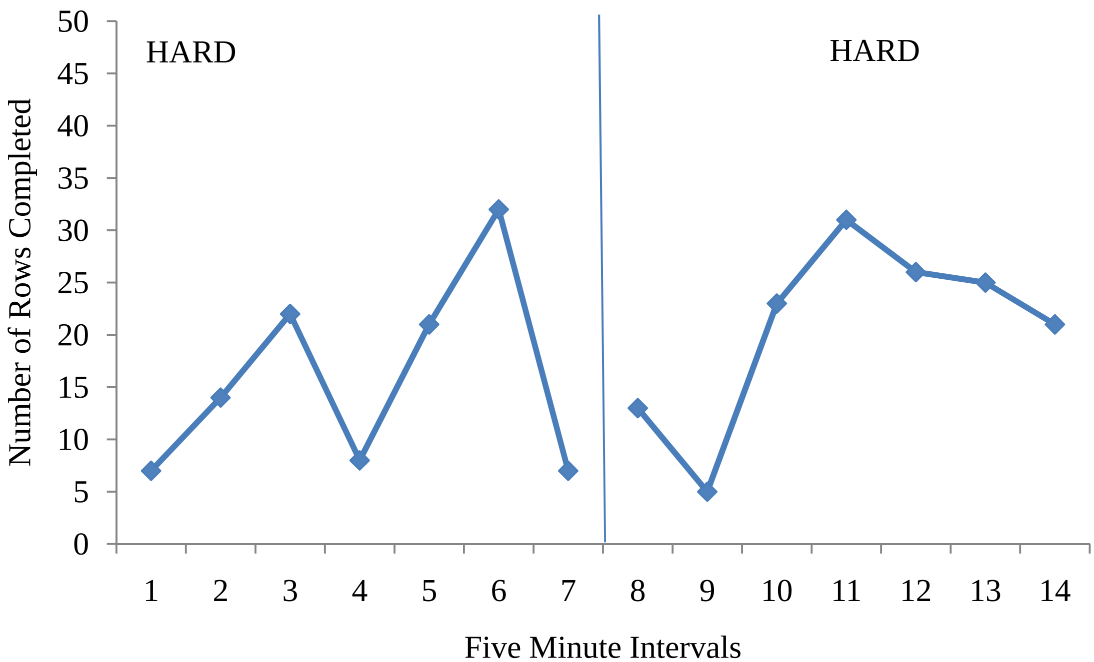

P1161 Game Performance
HARD
HARD
Number of Rows Completed
0
5
10
15
20
25
30
35
40
45
50
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Five Minute Intervals

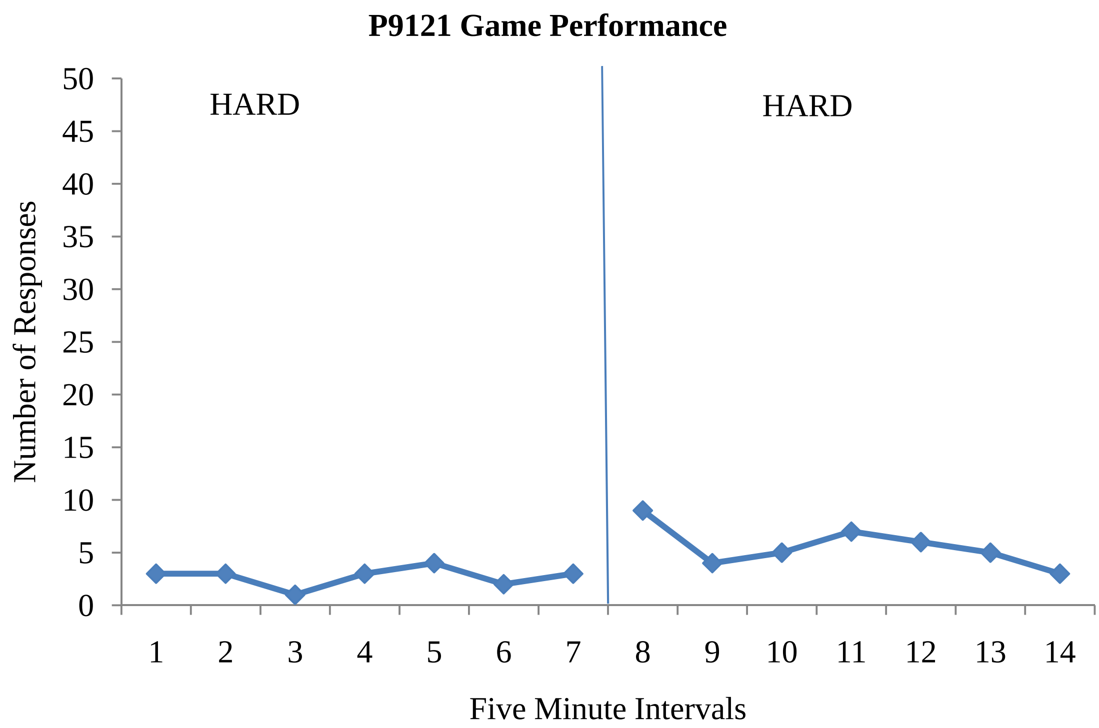

P5209 Game Performance
HARD
HARD
Number of Rows Completed
0
5
10
15
20
25
30
35
40
45
50
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Five Minute Intervals

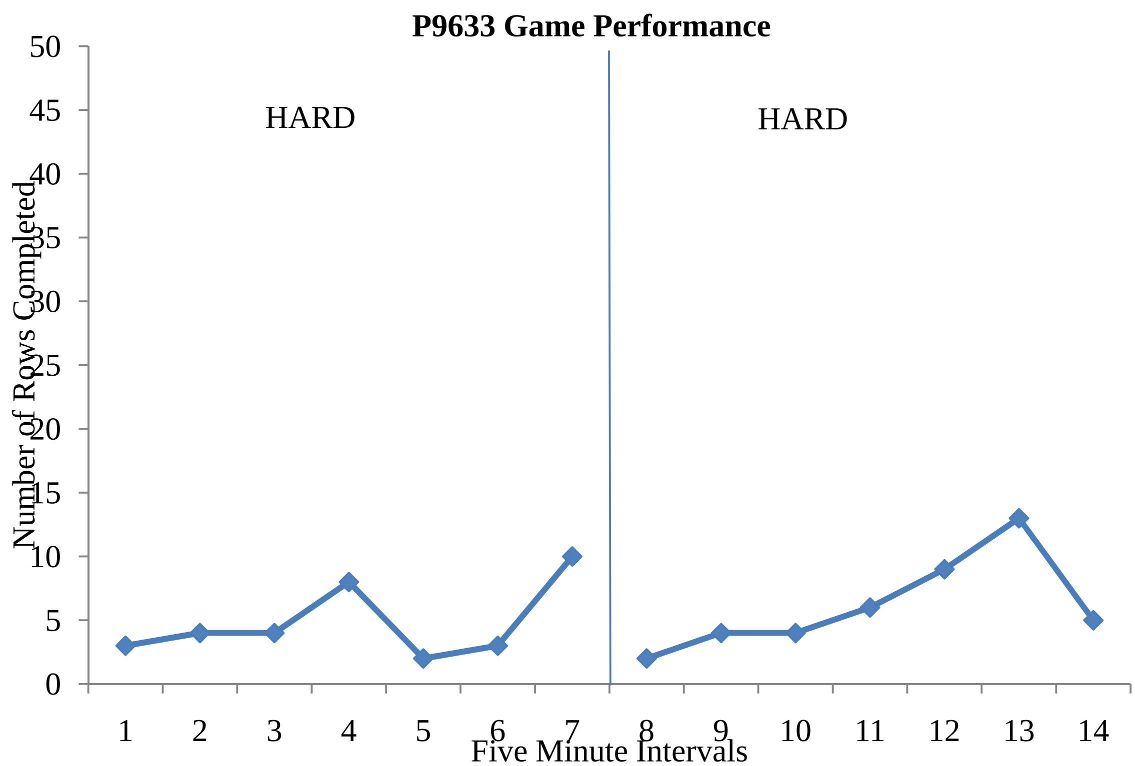
P2942 Game Performance



P7945 Game Performance

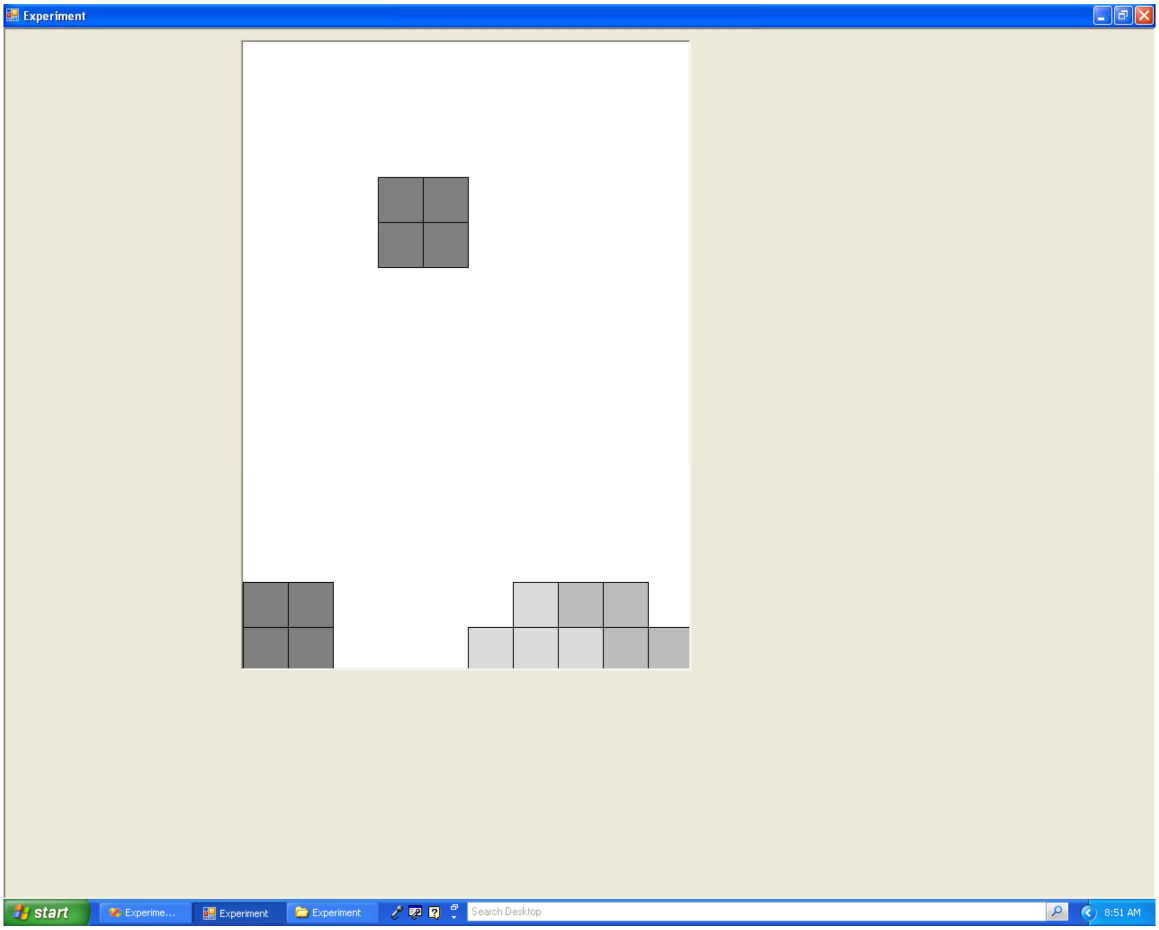



P9121 Game Performance
HARD
HARD
Number of Responses
50
45
40
35
30
25
20
15
10
5
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Five Minute Intervals


P9633 Game Performance
HARD
HARD
Number of Rows Completed
50
45
40
35
30
25
20
15
10
5
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Five Minute Intervals

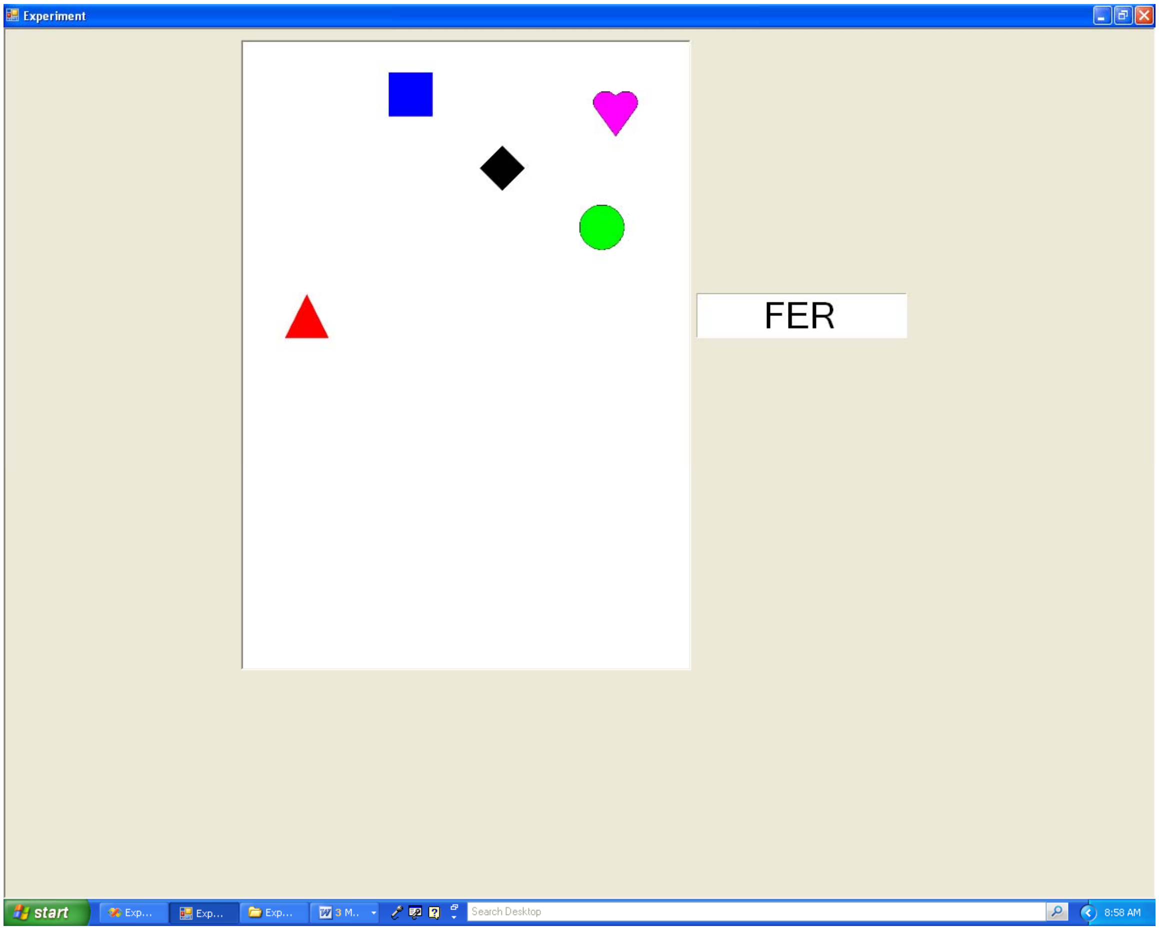
APPENDIX D

PRINT SCREEN OF THE PUZZLE PRACTICE TRIALS



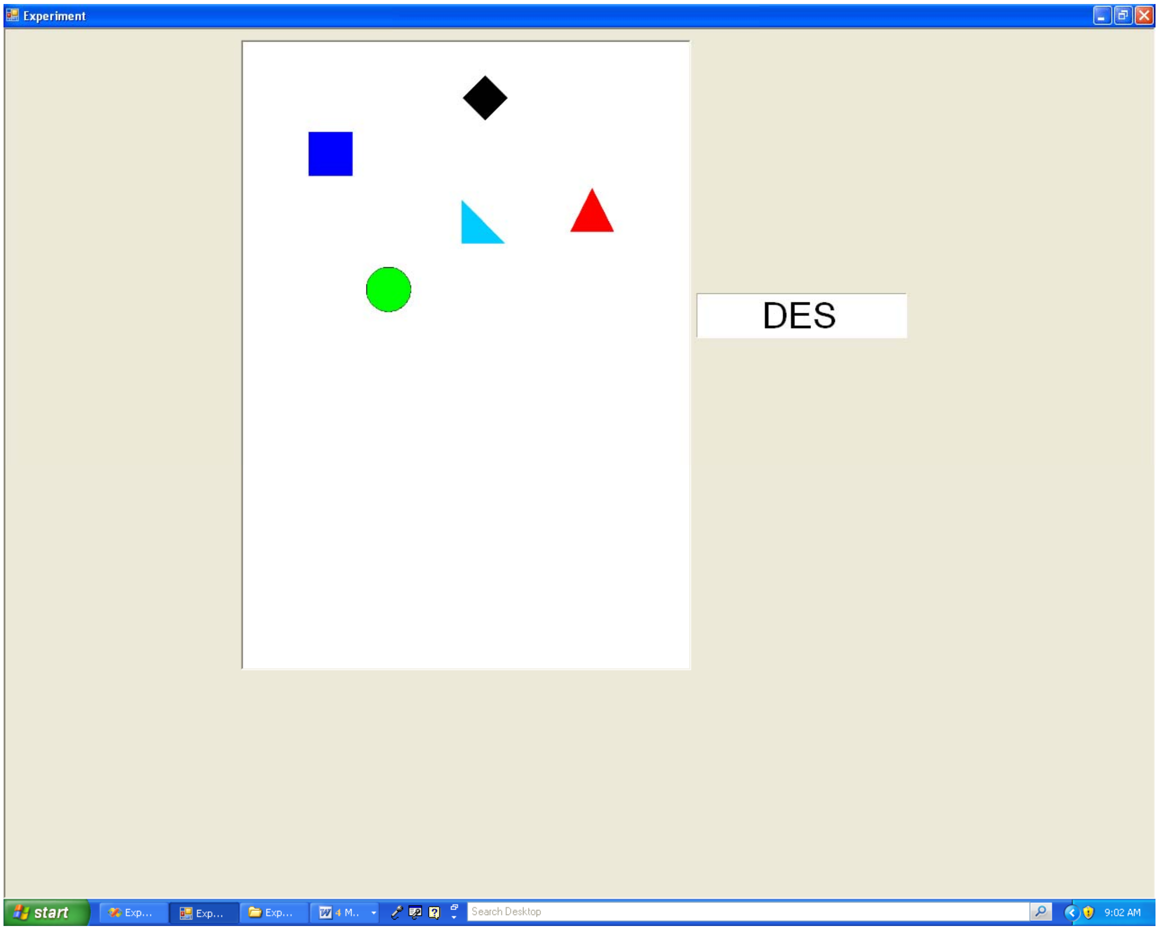
APPENDIX E

PRINT SCREEN OF THE NON-COMPOUND STIMULI PRACTICE TRIALS



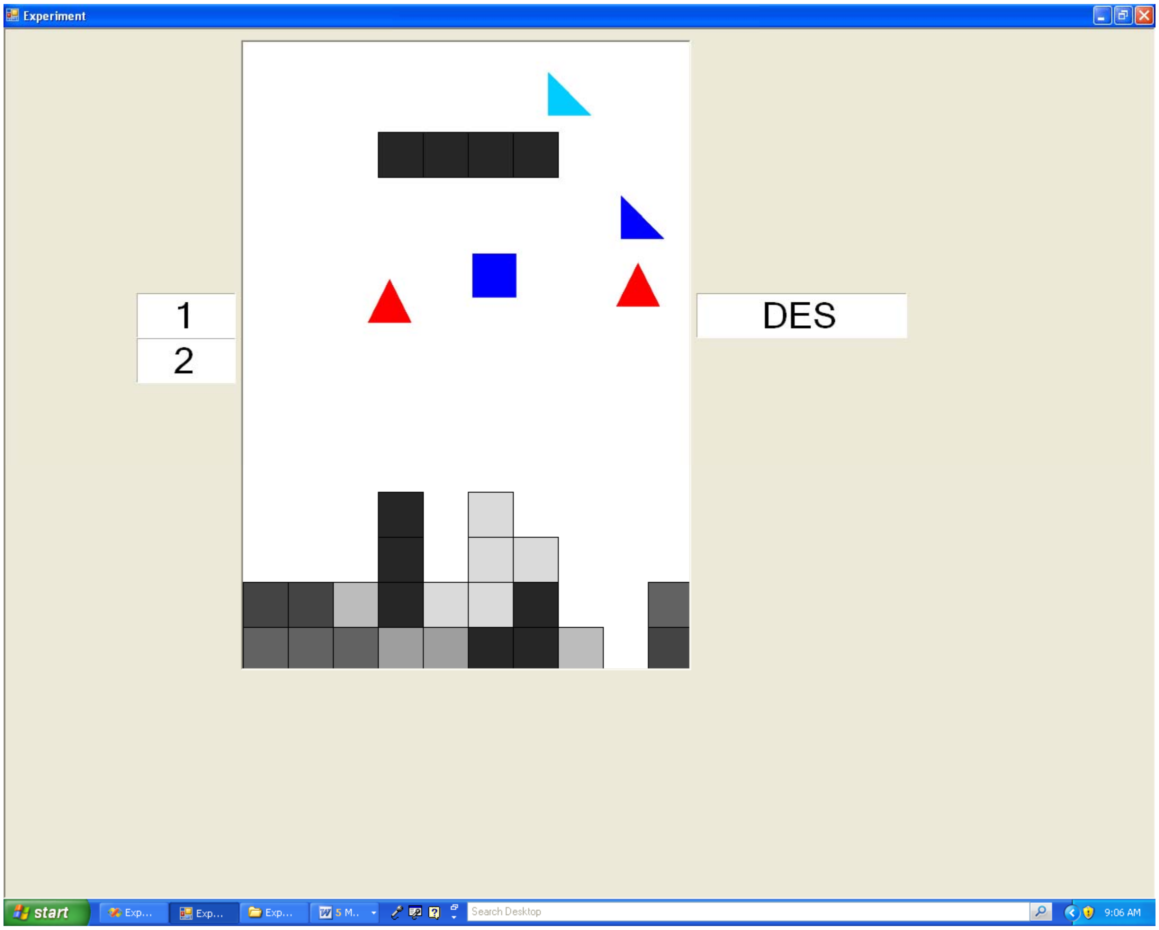
APPENDIX F

PRINT SCREEN OF THE COMPOUND STIMULI PRACTICE TRIALS



APPENDIX G

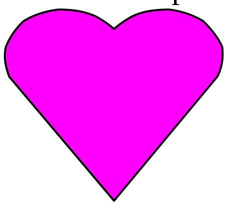
PRINT SCREEN OF THE GAME



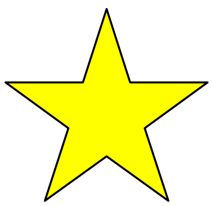
Appendix H

STIMULI FOR THE REMEMBERINGN TASK

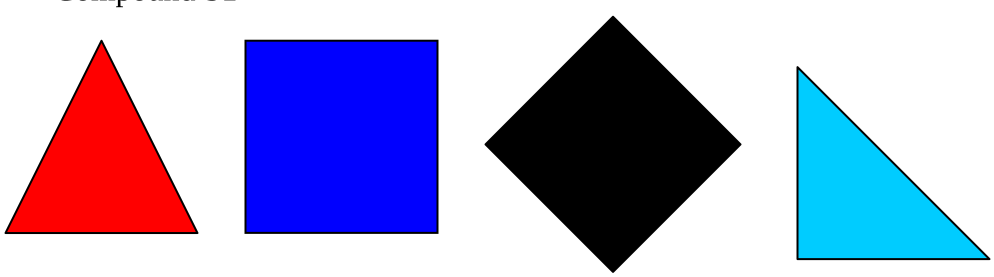
Non-compound S1



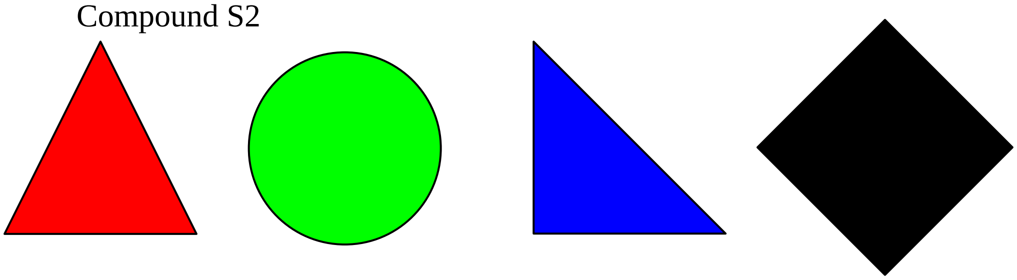
Non-compound S2



Compound S1



Compound S2



APPENDIX I

DESCRIPTION OF STUDY FORM

UNIVERSITY OF NEVADA, RENO
RESEARCH STUDY INFORMATION SHEET

Title of Study: Factors Influencing the Evolution of Remembering Interactions.
Investigators: Mitch J. Fryling, M.A., and Linda J. Hayes, Ph.D.
Phone number: (775) 351-6958
Protocol Number: E08/09-039

Purpose
You are being asked to participate in a research study. We hope to learn more about the basic principles of the process and applications of learning.

Participants
You have been asked to participate in this research because you are a student at the University of Nevada, Reno and are at least 18 years of age.

Procedures
You will be asked to work at a computer terminal and to engage in a game. This game will involve you responding to various shapes that pop-up on the top part of the screen, as well as place puzzle pieces into the bottom part of the screen. At the beginning of the experiment you will be given specific instructions and practice trials, to be sure you understand the game. You will respond to the shapes by typing various three letter nonsense words, and place the pieces into the puzzle by using the arrow keys. The puzzle pieces may or may not fall slowly or relatively fast during different parts of the game. Once you complete the instructions the game will take 70 minutes to complete. The entire experiment should take about 90 minutes for you to complete.

The purpose of the experiment will be explained in detail upon its completion. At this time, the experimenter will be able to answer any additional questions that you may have about the study.

Risks
There are no known risks involved in this experiment. You may experience fatigue, and may wish to go to the bathroom before, etc.

Benefits
There may be no direct benefits to you participating in this experiment. The field of psychology may benefit from this experiment in that it may advance our understanding of how humans engage in remembering responses over time.

Confidentiality
Your identity will be protected to the extent allowed by law. You will not be personally identified or tied to the data that we store, nor will you be identified in any reports or publications that may result from this study.

Title of Study: Factors influencing the evolution remembering interactions.
Investigators: Mitch J. Fryling, M.A., and Linda J. Hayes, Ph.D.
Phone number: (775) 351-6958
Protocol Number: E08/09-039

The electronic data from the experiment will be stored on a CD-ROM in a locked file cabinet in Linda J. Hayes, Ph.D. lab for a period of seven years. Once that period has ended, the disks will be shredded. The only authorized individuals or agencies that may examine the data are the investigators, Mitch J. Fryling, M.A., and Linda J. Hayes, Ph.D., and members of the University of Nevada, Reno Social Behavioral Institutional Review Board. Your responses, but no personal information, may be utilized in any reports or publications that may result from this experiment. We will inform your instructor that you participated in an experiment for course credit through the Psychology Subject Pool Database, but we will not disclose any other information about your participation apart from attendance.

Cost/Compensation
There will be no cost to you for participation in this study. We will provide you with two research credits for your participation in the study. Depending on your psychology instructor, he or she may give you extra credit for each research credit you earn (please check your syllabus). You will also be given $10 for your participation in the study.

Right to Refuse or Withdraw
You may refuse to participate or withdraw from the study at any time without penalty. You will receive compensation regardless of the time you spend participating in the research.

Questions
If you have any questions, please ask the experimenter. If additional questions arise later, please contact Linda J. Hayes, Ph.D., or Mitch J. Fryling, M. A., at UNR in the Department of Psychology at (775) 784-6828. You may ask about your rights as a human subject or you may report (anonymously, if you so choose) any comments, concerns, or complaints to the University of Nevada, Reno Social Behavioral Institutional Review Board, telephone number 775-327-2368, or by addressing a letter to the Chair of the Board, c/o UNR Office of Human Research Protection, 205 Ross Hall / 331, University of Nevada, Reno, Reno, NV 89557.