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The Effects of Matched and Unmatched Stimulation on the Behavioral Persistence of Stereotypy

A Thesis Presented

by

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The Department of Counseling and Applied Educational Psychology

In partial fulfillment of the requirements

for the degree of

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The Effects of Matched and Unmatched Stimulation on the Behavioral Persistence of Stereotypy

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Submitted In partial fulfillment of the requirements for the degree of
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Table of Contents

Abstract……..……..……..2

Introduction……..…….……3

General Method……..……..…….…..12

Participants and Setting……..……..12

Response Measurement and Interobserver Agreement……..……..13

Experiment……..……15

Phase 1 Functional Analysis……..……15

Method……..…….……..15

Functional Analysis Results.....……..……16

Phase 2 Competing Items Preference Assessment……..…….……17

Method……..……...17

Competing Items Results……...……..……17

Phase 3 Behavioral Persistence Tests……..……20

Method……..……...……20

Peristence test Results……....……..22

Discussion……..……..……24

General Discussion……..……29

References……..……..32

Diagram Captions……..……..35

Diagram……..……..36

Figure Caption……..……...37

Abstract

The predictions of the behavioral momentum metaphor and the proposed abolishing function of matched stimulation suggested by Rapp (2006, 2007) are contradictory. According to the metaphor stereotypy becomes more persistent when preferred items are used to compete with stereotypic responding (Ahearn et al., 2003). According to Rapp, if a participant engages with a matched stimulus the consequences of that engagement will abolish the reinforcement produced by stereotypy. As a result, stereotypy should subsequently decrease below baseline rates when that stimulus is removed. The experiment conducted in this study involves arranging multiple schedules with two participants to measure the persistence of stereotypy following exposure to variable-time (VT) schedules of matched and unmatched highly preferred and highly competing stimuli. The stimuli used during the disruption components for both participants did not effectively compete with the stereotypy and an effective comparison of the hypotheses could not be made. An effective disruptor was later identified for one of the participants (Lars) and was used for all disruption components of a subsequent series of persistence tests. In these tests the disrupting stimulus was less effective after exposure to VT-access periods in three out of the four sequences; showing the effects of momentum, but not of motivating operations. A within component analysis of the data was then made to assess whether the effects of matched and unmatched stimuli could be seen under a more molecular analysis. Results are discussed and further investigation is warranted.

The Effects of Matched and Unmatched Stimulation on the Behavioral Persistence of Stereotypy

In an attempt to improve the effectiveness of treatments for automatically maintained behavior, there has been a growing effort to develop a method through which the function of such behavior can be identified. Through a combination of functional and indirect assessments, various researchers have suggested that automatically reinforced behavior can be maintained by more than one type of sensory stimulation, and that stimuli that match the hypothesized sensory consequences of the target behavior can reduce its rates of occurrence to below baseline levels (Ahearn, Clark, DeBar, & Florentino 2005; Piazza, Adelinis, Hanley, Goh, & Delia, 2000; Piazza, Fisher, Hanley, LeBlanc, Worsdell, Lindauer et al., 1998).

One method suggested for reducing rates of stereotypy operates under the assumption that matched stimuli satiate the individual of the consequences provided by stereotypy and abolish their effects as reinforcement (Piazza et al., 2000). Alternatively, restricting the opportunity for an individual to engage in stereotypy deprives him of the consequences provided by it and establishes its consequences as reinforcement. Rapp (2006, 2007) outlined a method for empirically identifying whether stimuli substitute for, or compete with, the stimulation produced by stereotypy by looking at rates of responding after reinforcement. If post-reinforcement responding rose above baseline rates, then it was assumed that the stimulation provided was not matched. Conversely, if responding fell below baseline

rates, then it was assumed that the stimulation provided was matched. (Rapp, 2006; Rapp, 2007; Rapp, Vollmer, Dozier, St. Peter, & Cotnoir, 2004).

Although the results of these studies indicate that it may be possible to identify at least some of the maintaining variables of behavior previously thought to be unidentifiable, they do not appear to line up conceptually with results of similar research done to analyze the phenomenon of behavioral momentum. Response rate is determined by a response-reinforcer relation. This means that when reinforcement is provided contingent upon a response, the number of responses that will occur within a given period of time will increase, decrease, or remain constant depending on the schedule that the reinforcement is being delivered on. Resistance to change (i.e. extinction, disruption, or satiation) is determined by a stimulus-reinforcer relation. This means that all reinforcement (regardless of whether it is presented contingently, non-contingently, or contingent upon a different response) delivered in a specific context (i.e. the stimuli present when behavior is reinforced) will contribute to behavior's resistance to change. Behavioral momentum is a metaphor that has been used to describe behavioral persistence in a number of species (Ahearn, Clark, Gardenier, Chung, & Dube, 2003; Dube, & McIlvane, 2001; Grimes, & Shull, 2001; Mace, Lalli, Shea, Lalli, West, Roberts, et al., 1990; Nevin, Tota, Torquato, & Shull, 1990). It was developed as an analogue to the concept of momentum (the product of mass and velocity) found in physics. In this comparison, response-reinforcer rate is analogous to velocity, stimulus-reinforcer rate is analogous to mass and response persistence in the presence of disruption is analogous to momentum (Nevin, 1992). One implication of the behavioral momentum metaphor is that the more

reinforcement that is delivered in the presence of a stimulus (whether it's presented contingently or not), the more resistant to disruption (e.g. extinction or satiation) a response will be that is emitted in the presence of that same stimulus.

Laraway, Snycerski, Michael, and Poling (2003) formalized a set of vocabulary for describing environmental events that alter the value of reinforcing and/or punishing properties of various stimuli, and the stimuli's effect on behavior. In the article, the term "establishing operation" is used to describe an event that increases the reinforcing or punishing values of a stimulus, and makes responding that is contingent on obtaining that reinforcer, or escaping that punisher, more likely to occur. The term "abolishing operation" is used to describe an event that decreases the reinforcing or punishing values of a stimulus, and makes responding that is contingent on obtaining that reinforcer, or escaping that punisher, less likely to occur.

Many studies have been done to analyze the effects that manipulating motivating operations have on the occurrence of aberrant behavior. Piazza, Fisher, Hanley, LeBlanc, Worsdell, Lindauer, et al. (1998) conducted a series of reversals on the automatically maintained pica of three individuals. In the first phase of the study they found that non-contingent attention was effective in reducing rates of pica, but that the reduction was clinically unacceptable. In the next phase of the study, a series of single stimulus preference assessments were conducted and highly preferred stimuli were identified and categorized according to whether or not they did or did not matched the overt consequences hypothesized to be maintaining the pica for each individual. The authors found that the highest rates of stimulus interaction and lowest rates of pica during the preference trials were in the trials in which the matched

stimuli were presented. The results of ABAB treatment reversals demonstrated that the most effective competing stimuli had properties that matched the overt properties of the things that were most commonly ingested in pica.

In 2000, Piazza, Adelinis, Hanley, Goh, and Delia reported a study to extend the findings of Piazza et al. (1998) to other forms of automatically reinforced aberrant behavior. The behaviors chosen for the study were saliva play, hand mouthing, and dangerous behavior, and had all been identified to be automatically maintained through a functional analysis similar to the one outlined by Iwata et al. (1982/1994). In the study, a series of stimuli were evaluated based on the competing items preference assessment outlined in Piazza et al. (1998). The stimuli were separated into two groups: matched (stimuli that they hypothesized to have properties similar to those that maintained the automatically reinforced aberrant behavior) and unmatched (stimuli that did not have anything in common with the hypothesized maintaining variables of automatically reinforced aberrant behavior). The authors then isolated the stimulus from each group that had been engaged with the most frequently (highly preferred), and in whose presence the aberrant behavior occurred the least (highly competing). The most highly preferred/competing stimulus from each group was then provided during a multi-element reversal design to determine which type of stimulation more effectively competed with the aberrant behavior. The results of the study found that matched stimulation competed more effectively than did unmatched stimulation.

In an extension of the Piazza et al. (2000) study, Ahearn, Clark, DeBar, and Florentino (2005) conducted a series of duration-based preference assessments to

identify highly preferred, highly competing matched and unmatched stimuli to the hypothesized maintaining variables of automatically reinforced stereotypy. Similar to the methods of Piazza et al., they took the most preferred, most competing stimulus from each category (matched and unmatched) and used them in a multi-element design to determine which would more effectively compete with stereotypy. Ahearn et al. found that matched stimulation reduced rates of stereotypy below baseline levels. In contrast to the Piazza study, however, Ahearn et al. found that the unmatched stimuli could reduce rates of stereotypy as effectively and sometimes more effectively than the matched stimuli.

Using a series of reversal designs, Rapp, Vollmer, Dozier, St. Peter, and Cotnoir (2004) analyzed the effects that response restriction of the most probable form of stereotypy would have on other, less probable, topographies. In three out of the four participants, the results showed that response restriction increased the frequency of responding for the other forms of stereotypy. In later response restriction reversals, the data showed that, for some participants, rates of stereotypy actually increased above baseline levels after a response restriction component. The authors then assessed whether an environmental enrichment procedure would also produce similar collateral effects and found that, although the environmental enrichment procedure was not effective in reducing rates of stereotypy for all participants, it did not produce increases in other forms of stereotypy for any of them. The authors drew three conclusions from their data: 1) Interventions intended to reduce specific behavior may also alter the frequency or form of untargeted behavior, 2) stimulation matched to the overt products of the target behavior compete with it

better than do other forms of stimulation, and 3) stereotypy may increase above baseline after a response restriction procedure has been implemented and removed.

Rapp (2006) noted that in studies in which matched stimuli were used to compete with the reinforcing effects produced by automatically maintained stereotypy, it was not known whether the matched stimuli substituted for, or competed with the target behavior. By assuming that providing stimulation that substitutes for stereotypy will abolish its reinforcing effects, and providing stimulation that competes with it will establish its reinforcing effects, Rapp outlined a method to indirectly assess whether or not stimulation is matched. He used a multiple schedules design that consisted of three components: baseline (pre), response restriction or non-contingent matched stimulation (NMS), and baseline (post). The results of the experiment showed that NMS reduced stereotypy to near zero levels and rates of stereotypy in the post-baseline were lower than rates of stereotypy in the pre-baseline, suggesting that satiation had occurred. Conversely, rates of stereotypy in the post-baseline component of response restriction increased above those of the pre-baseline component, suggesting deprivation.

Rapp (2007) extended the findings of Rapp (2006) to more participants and stimuli. Using a combination of preference assessments, reversal, and multi-element designs, Rapp confirmed his earlier findings that stimuli hypothesized to match the stimulation provided by stereotypy decreased rates of stereotypy below baseline levels in post-reinforcement components; and response blocking increased rates of stereotypy above baseline in post-treatment components, further verifying the

indication that there is a way to indirectly assess whether stimulation competes with, or substitutes for, automatically reinforced behavior.

Research in the field of behavioral momentum predicts results different than those reported by Rapp (2006, 2007). In 1974 Nevin evaluated the effects of disruption on the response persistence of pecking for pigeons on a multiple variable-interval variable-interval (VI VI) schedule. In the experiment, Nevin used different colored lights (red and green) to function as discriminative stimuli to assist in the differentiation between different variable interval schedules. Once differentiation between conditions was established and responding stabilized during each schedule, the effects of satiation and extinction were evaluated. Nevin found that the frequency, magnitude, and delay of reinforcement, as well as the rate of responding, all affected the response's resistance to change in the presence of disruption (i.e. satiation and extinction). Nevin suggested that the term "response strength" be used to describe a response's resistance to change, and the behavioral momentum metaphor emerged to facilitate the description of important variables that contribute to the persistence of behavior. The metaphor has since been generally well established in basic research (Nevin, 1992; Nevin, Tota, Torquato, and Shull, 1990).

Grimes and Shull (2001) conducted a study with rats that analyzed whether the response-independent reinforcers (i.e. reinforcers whose delivery was not contingent upon the emission of the target response) given during a behavioral persistence experiment could be different (unmatched) from the response-dependent reinforcers and still yield results consistent with the momentum theory. In the experiment, milk was the response-independent reinforcer, and food pellets were the

response-dependent reinforcers. The results of the experiment showed that the milk deliveries enhanced the behavioral persistence of pellet-reinforced lever pressing and provided further evidence to support the idea that any reinforcer (whether identical to response-dependent reinforcers or not) delivered in the presence of a stimulus increases the persistence of a response that occurs in the presence of that stimulus. The authors did acknowledge, however, that even though the reinforcers were different, it is likely that they both belong to the same motivational class, and they encouraged more research to verify their findings.

Mace, Lalli, Shea, Lalli, West, Roberts, et al. (1990) extended the findings of basic research to humans by conducting a study with two mentally handicapped adults. In the study, reinforcement was delivered contingent on sorting behavior. Response-independent reinforcement was also provided during specific conditions. Colors were used to help the participants discriminate between conditions. A disruptor (television) was then used to evaluate the persistence of sorting in the presence of the discriminative stimuli for each condition. The authors found that sorting persisted more in the presence of the color in which response-independent reinforcement was provided in addition to response-dependent reinforcement, than in the presence of the color in which only response dependent reinforcement was provided. These results are consistent with previous basic research and with the behavior momentum metaphor.

In an applied setting, Ahearn et al. (2003) demonstrated the effect that delivering a reinforcer on a variable-time (VT) schedule (a technique commonly used to treat stereotypy) has on the behavioral persistence of automatically maintained

stereotypic behavior. In the study, multiple schedules were arranged so that pre- and post-baseline components were compared to the immediate effects that VT competing stimulus presentations had on stereotypy, as well as the effects that those VT stimulus presentations had on the persistence of stereotypy in the presence of disruption (continual access to a competing stimulus) in a subsequent condition immediately following VT reinforcement. The data show that, while VT reinforcer delivery decreased immediate rates of stereotypy, it simultaneously increased its persistence in the presence of subsequent disruption. These findings extend the generality of the behavioral momentum metaphor to stereotypy in a clinical setting.

As a result of continual research, the variables related to behavioral persistence are becoming increasingly apparent. According to research, a reinforcer presented in the presence of a discriminative stimulus, regardless of its properties, increases the behavioral persistence of responding in the presence of that discriminative stimulus. Under these parameters, non-contingent access to any reinforcer (matched or unmatched) should increase the persistence of behavior.

In contrast, there are a growing number of studies that indicate that specific properties of a reinforcing stimulus will dictate different kinds of subsequent behavior depending on the motivating operations in place. The two bodies of knowledge come to a direct contradiction when predicting the effects of matched stimulation on behavioral persistence. According to momentum theory if reinforcement is provided in the presence of the stimuli present when behavior occurs, rates of responding should persist in disruption above rates measured in a baseline in which reinforcement was not provided before disruption. Conversely, according to what we

know about motivating operations, if reinforcement abolishes the effects of stereotypy through satiation, rates of responding during subsequent disruption should reduce below baseline rates in which disruption was provided without previous exposure to satiation. The purpose of this study was to investigate whether the type of stimulation provided (matched or unmatched) would produce differential results in the persistence of stereotypy. Functional analyses and single stimulus preference/competing items assessments were conducted on the motor stereotypy of two participants. Using highly preferred matched and unmatched competing stimuli, multiple-schedules were arranged to assess the effects that a variable-time scheduled presentation of these reinforcers would have on the persistence of stereotypy during disruption.

General Method

Participants and Setting

Both participants lived in a residential facility that specialized in the care of individuals with autism. Greg was a 19-year-old male who had been diagnosed with autism and Obsessive Compulsive Disorder. He had an extensive history of aggression, severe self-injury, and emitted various forms of motor stereotypy. Lars was a 19-year old male diagnosed with autism, and had a history of elopement and various forms of rapid motor stereotypy.

All sessions were conducted in a room of a school that specialized in the instruction of children with autism. The room measured 1.5 m x 3 m and was equipped with a mounted, wide angle, camera and a one-way mirror for observation.

Response Measurement and Inter-observer Agreement

The dependent variables in this study were item engagement, rocking for Greg, and hand stereotypy for Lars. *Item engagement* was defined as any part of the participants body touching any part of the item presented. *Rocking* was defined as any instance of Greg shifting the support of his weight between his front an back leg, without switching the position of either leg. Instances began when Greg shifted his weight from his front to his back leg, and back to his front again. Instances ended when Greg started to walk, or when he stopped shifting his weight. *Hand stereotypy* for Lars was defined as any rapidly moving non-functional hand or finger movements. Examples included finger fluttering, hand flapping, clapping, and floor or wall slapping. Non-examples consisted of stretching, signing, and scratching.

Interobserver agreement (IOA) was taken by two trained board certified behavior analysts currently enrolled in a Ph. D. program for behavior analysis. During the competing-items assessment, the occurrence and non-occurrence of hand stereotypy, rocking, and item engagement was measured in 1-s intervals every 10-s across 3-minute sessions using momentary-time sampling. Interobserver agreement (IOA) was measured for 32% of the sessions for Greg and for 40% of the sessions for Lars. Agreements and disagreements were scored interval by interval. Session IOA was determined by dividing the number of agreements by the total number of agreements plus disagreements and multiplying by 100. For Greg the mean agreement for the competing items assessment was 98% with a range of 94%-100% for stereotypy and 99% with a range of 94%-100% for item engagement. For

Lars the mean agreement was 82% with a range of 56%-100% for stereotypy and 94% with a range of 83%-100% for item engagement.

During the analog functional analysis and the behavioral persistence tests, the occurrence and non-occurrence of rocking and hand stereotypy was scored for every second of each 5-min session or component. For Greg, agreement was scored second by second, and session/component IOA was determined by dividing the number of agreements by the total number of agreements plus disagreements. IOA was measured for 79% of sessions for Greg's functional analysis and for 25% of his persistence tests. During the functional analysis the mean agreement was 98% with a range of 96%-100%. During his persistence tests the mean agreement was 98% with a range of 96% -100%. IOA was measured for 25% of Lars' persistence tests and functional analysis sessions. Due to the erratic and spontaneous nature of Lars' stereotypy, agreement to the exact second in which his stereotypy occurred was difficult to obtain. As a result, IOA for each session was calculated by dividing the total number of seconds in which Lars engaged in stereotypy measured by one observer, by the total number of seconds measured by the other observer and multiplying by 100. For Lars' functional analysis the mean agreement was 94% with a range of 92%-95%. During Lars' first series of persistence tests the mean agreement was 86% with a range of 81%-97%. During his second series of persistence tests the mean agreement was 92% with a range of 85%-99%.

Experiment

Phase 1: Functional Analysis

Method. A modified functional analysis was conducted using procedures based those described by Roscoe, Carreau, MacDonald, and Pence (2008). Three conditions were presented (social attention, demand, and alone) in the following order: Alone, alone, attention, alone, alone, demand. Three sessions were run per day (e.g., alone, alone, attention, *or* alone, alone, demand). The purpose of the functional analysis was to determine whether the stereotypic behavior of each participant was maintained by social variables.

During the *alone* condition, a chair and a desk were present. The therapist guided the student into the room and said, “Wait here; I’ll be back in a few minutes”. The therapist then left the room and observed the student through a one-way mirror. All behavior was ignored.

During the *social attention* condition a chair and a desk were present. At the beginning of each session, the therapist gave the cue, “Please sit here; I need to do some work”, and began engaging in another activity. Contingent upon the target response, the therapist lightly touched the student on the shoulder and varied statements such as, “Stop that” and “don’t do that” every five seconds that the target behavior was emitted. All other responses were ignored.

During the *demand* condition, there was a chair, a desk, and materials needed to complete each demand presented. During this condition, the therapist issued a series of demands (e.g., “put the cup in corner. Put the clips in the cup. Wipe the wall with the cloth. Sit down. Arms up.”). Upon the completion of each demand

the therapist gave brief verbal praise and presented the next demand. Contingent on non-compliance, the teacher delivered a prompt every five seconds following a prompt hierarchy (verbal, model, manual guidance) until the task was completed. Verbal praise was delivered for correct responses only if the final physical prompt was not given. Contingent upon emission of the target response, the therapist said, "OK, you don't have to," removed the task materials for 15 seconds, and turned away from the student. At the end of 15 seconds the therapist re-presented the demand. Contingencies for breaks from demands and verbal praise remained constant throughout the session. All other behavior was ignored.

Functional Analysis Results. The results of Greg's functional analysis can be seen in Figure 1. During the alone condition, rates of stereotypy ranged from 14% to 78%, with a median of 40.5%. No stereotypy occurred during either of the two attention conditions. During the demand condition, stereotypy occurred for 48% and 30% of the first two sessions (respectively), with a mean rate of 39%. These results suggested that escape could be a possible maintaining variable; however, some of the demands presented required Greg to stand up and move around. Because being on his feet presented the opportunity to rock, and standing up served a possible discriminative function for rocking, a series of table top demands were presented to Greg in an extended demands condition to see if rocking would persist of Greg was not required to stand up to complete each task. The results showed that when only table top demands (i.e. put the cup in corner of the table. Put the clips in the cup. Wipe the wall (in front of the table) with the cloth. Stuff the envelope. Arms up) were presented to Greg, stereotypy reduced to rates of 4% and 0% of occurrence

during each session. With these results, the authors felt confident that rocking was maintained by automatically produced variables, not socially mediated ones.

The results of Lars' functional analysis can be seen in Figure 2. During the demand condition, hand stereotypy occurred for 28% and 3% of each session, with a mean rate of 15.5%. During the attention condition, hand stereotypy occurred for 25% and 14% of each session, with a mean rate of 19.5%. During the alone condition rates ranged from 22% to 75%, with a medium of 46% of within session stereotypy. These results indicate that the hand stereotypy of Lars is automatically maintained, and that social attention and the presentation of demands are ways in which overall rates of stereotypy can be reduced.

Phase 2: Competing-Items Assessment

Method. A competing items preference assessment was conducted based on the procedure described by Piazza, Fisher, Hanley, Hilker, and Derby (1998) and Piazza, Adelinis, Hanley, Goh, Delia (2000) Items were selected based on how well they matched or did not match the hypothesized reinforcing sensory consequence of the stereotypic behavior.

Sessions were identical to the alone condition of the functional analysis, with the following exceptions; during each session the participants had continuous access to a stimulus hypothesized to compete with their stereotypy. Sessions lasted three min, and were divided into 10-s intervals. Data was taken using momentary time sampling (MTS) on the percentage of intervals that the student interacted with the item, as well as on the percentage of intervals in which the participant engaged in stereotypy. Eight stimuli were evaluated at a time. The stimuli were presented in

succession so that, when three minutes of exposure to one stimulus ended, the session ended, the stimulus was removed, a new stimulus was presented, and a new session began. Each stimulus was presented three times.

Competing-Items Assessment Results. The results of Greg's competing items assessment can be seen in Figure 3. When presented with the rocking chair, the mean levels of item engagement were 85.33% and the mean rates of stereotypy were 5.67%. In the presence of the therapy ball mean levels of item engagement were 85% and mean rates of stereotypy were 5.67%. In the presence of the pinboard mean rates of item engagement were 75.67% and mean rates of stereotypy were 31.67%. In the presence of the yellow ball mean levels of engagement were 66.67% and mean levels of stereotypy were 64.67%. In the presence of the chair mean levels of engagement were 60.67% and mean levels of stereotypy were 2%. In the presence of the radio mean levels of engagement were 44.33% and mean levels of stereotypy were 87%. In the presence of the jump-board mean levels of engagement were 24% and mean levels of stereotypy were 27.67%. In the presence of the basketball mean levels of engagement were 20.33% and mean levels of stereotypy were 62.67%. Thus, the items that had the highest rates of engagement were there rocking chair, therapy ball, pinboard, yellow ball, and chair. The items that were correlated with the lowest rates of stereotypy were the chair, rocking chair, therapy ball, jump board, and pinboard.

The results of Lars' competing items assessment can be seen in Figure 4. In the presence of the monkeys the mean level of engagement was 100% and the mean level of stereotypy was 5.67%. In the presence of the face massager the mean level of engagement was 100% and the mean level of stereotypy was 9.33%. In the presence

of the worm toy the mean level of engagement was 89% and the mean level of stereotypy was 9.33%. In the presence of the Koosh ball the mean level of engagement was 66.67% and the mean level of stereotypy was 4%. In the presence of the car dice the mean level of engagement was 66.67% and the mean level of stereotypy was 13%. In the presence of the slinky the mean level of engagement was 55.33% and the mean level of stereotypy was 20.33%. In the presence of the feather the mean level of engagement was 54% and the mean level of stereotypy was 16.67%. In the presence of the sanding sponge the mean level of engagement was 48%, and the mean level of stereotypy was 31.67%. In the presence of the spinning globe the mean level of engagement was 39% and the mean level of stereotypy was 20.33%. In the presence of the round massager the mean level of engagement was 35.33% and the mean level of stereotypy was 41%. In the presence of play doh the mean level of engagement was 26% and the mean level of stereotypy was 24%. In the presence of the paddles the mean level of engagement was 11.33% and the mean level of stereotypy was 50%. In the presence of the pinboard the mean level of engagement was 9.33% and the mean level of stereotypy was 16.67%. In the presence of the roller paintbrush the mean level of engagement was 9.33% and the mean level of stereotypy was 50%. In the presence of the lacing toy the mean level of engagement was 7.67% and the mean level of stereotypy was 15%. In the presence of the gripping toys the mean level of engagement was 0% and the mean level of stereotypy was 31.33%. Thus, the items with the highest levels of engagement were the monkeys, face massager, worm toy, koosh ball, car dice, and slinky. The items

correlated with the lowest levels of stereotypy were the Koosh ball, monkeys, face massager, worm toy, car dice, and lacing toy.

After running a series of unsuccessful persistence tests with Lars that were a result of not having identified preferred stimuli that were effective in competing with stereotypy, a second assessment was conducted. The results of this assessment were combined with those of the original assessment seen in Figure 4. In the presence of the second koosh ball mean levels of engagement were 100% and mean levels of stereotypy were 27.78%. In the presence of the glitter stick the mean level of engagement was 63.89% and the mean level of stereotypy was 33.34%.

Phase 3: Persistence Tests

Method. One matched highly preferred/highly competing stimulus and one unmatched highly preferred/highly competing stimulus were selected for each participant. One unmatched highly preferred stimulus was selected to be used for each participant and was used during all test components. Highly preferred items were items that the student engaged in more than 60% of the intervals. For Greg, the therapy ball was chosen to be used as the highly preferred and highly competing matched stimulus. The chair was chosen to be used as the highly preferred and highly competing unmatched stimulus. The pinboard was chosen to be used as the highly preferred and highly competing unmatched stimulus to be used during all test components. For Lars, the face massager was chosen to be used as the highly preferred and highly competing matched stimulus. The worm toy was chosen to be used as the highly preferred and highly competing unmatched stimulus. The slinky

was chosen to be used as the highly preferred highly competing unmatched stimulus to be used during all test components.

A multiple-schedule was used to measure the behavioral persistence of stereotypy. In the design, levels of stereotypic behavior were measured across three components: Baseline, variable-time (VT) exposure to a matched or an unmatched competing highly preferred stimulus, and test (continuous exposure to an unmatched stimulus). These three components were conducted in three sequences: a control sequence (A), a VT matched stimulus test sequence (B), and a VT unmatched stimulus test sequence (C). Only one sequence was conducted during any single day. As outlined in Diagram 1, the test sequences were conducted in the following order: baseline, VT exposure, test, baseline. The control sequence was conducted in the order: baseline, baseline, test, baseline. In this way, baseline components preceded one half of the test components, and VT exposure preceded the other half.

Every subject was exposed to each sequence in an ABACABAC fashion (A=Control, B=Matched VT, C=Unmatched VT). Each component lasted five minutes (with the exception of the VT-components and their corresponding baselines in the control sequence. These components lasted six and a half minutes).

During the baseline components the therapist remained in the room but, with one exception, did not attend to the behaviors of the participants (Greg has severe self-injury that is hypothesized to be attention maintained. Greg asked very few questions during any given component but, in order to avoid dangerous self-injury, questions that Greg did ask were responded to with simple one word “yes” or “no” answers). No furniture was left in the room. The VT exposure component was

identical to baseline except that were three 30 second access periods in which the participant had access to the highly preferred competing stimulus. The stimulus' presentation was determined quasi-randomly according to a VT schedule range. Data on stereotypic behavior that occurred during the access periods were not included in the results.

The duration of the second baseline in the control condition was yoked to the duration of the VT exposure component of the subsequent test sequence. Time intervals that corresponded to the access periods during the test sequence were omitted from the data analysis in the control condition.

While conducting the first B sequence, the therapist allowed Greg to access the matched stimulus for over a minute and a half during one of the 30-s access periods before realizing that the 30-s access period had concluded. Although the entire sequence (and not just the component) was re-conducted; because it was run within the same hour of the same day, it is not certain that the extra access to the matched reinforcer did not affect the results of the subsequent persistence sequence. In order to control for this, Greg was exposed to a third B sequence at the end of his persistence series so that he was exposed to each sequence in an ABACABACAB fashion.

The results from these persistence tests showed that the stimuli chosen as disruptors for the test components did not actually compete with stereotypy. After a second preference assessment was conducted, a new disrupting stimulus (2nd Koosh ball) was identified to be used for all test components of a second series of persistence tests for Lars.

Due to the logistical complications of extending Greg's preference assessment to find items that provided stronger competition against his rocking stereotypy (e.g. using the items that were identified anecdotally to provide the strongest forms of competition such as swing sets and larger rocking chairs were not practical substitutes), Greg's tests persistence tests were not repeated.

Persistence Test Results. Figures 5 and 6 show the results of Greg's and Lars' behavioral persistence tests. The Y-axes show the percentage of time in which stereotypy occurred during each component; the X-axes specify under which component the stereotypy occurred and the phase change lines represent the commencement of a new persistence sequence. Within each phase there are four bars. The first and fourth bars represent baseline rates of stereotypy. The third bar represents rates of stereotypy in the presence of continuous access to a disrupting stimulus. The second bar represents one of three different possible components and is color coded to indicate which is being represented: Black represents rates of stereotypy that occurred in a second baseline during control sequences. Gray represents rates of stereotypy that occurred in a VT-Matched component during VT-Matched sequences. White represents rates of stereotypy that occurred in a VT-Unmatched component during the VT-Unmatched sequences.

To facilitate the visual analysis of determining whether or not matched and unmatched stimuli produced differential outcomes, Figures 7 and 8 have separated and grouped matched sequences and unmatched sequences for both Greg and Lars to assist in their differentiation; additionally, in order to evaluate relative changes in behavior between test and control sequences, Figures 9, 10, and 13 show test to

baseline proportional ratios. The proportions were calculated by dividing either the second (VT exposure/baseline) or third (test) components of the sequence by the average percentage of stereotypy from the first (baseline) and fourth (baseline) components. For both Greg and Lars, the disrupting stimulus used in the test components did not show strong competition with the target stereotypy. Furthermore, although the highly preferred matched and unmatched stimuli used during the VT components competed with stereotypy during access periods when data was not being taken, they did not demonstrate strong lasting effects of competition when the stimuli were removed and data were again taken.

Figure 11 shows the results for Lars' second series of behavioral persistence tests. Figure 12 displays graphs comparing matched sequences to unmatched sequences. Unlike the previous two series, this series produced effects predicted by behavioral persistence in three out of the four sequences. The only time the effects of behavioral momentum could not be observed where in the second series of tests (the first VT-unmatched sequence and the second control sequence). In this series, the competition provided by the test stimulus was too strong during both sequences and rates of stereotypy remained at zero for the duration of both test components.

Discussion. Even though the test stimuli did not effectively compete with the target stereotypy for either participant, because the stimuli used for the test were constant across all sequences for both participants, the effects of matched and unmatched VT stimulation could still be observed. For Figures 9 and 10 the X-axes display the sequence being represented, and the Y-axes display the specific sequence's test component divided by the average of the first and final baseline

components of the same sequence. Figure 9 shows Greg's results. It is interesting to note that if the first VT matched sequence is ignored (which contained the procedural integrity error) the test to average baseline proportions taken from both VT matched sequences are lower than the proportions taken from the control sequences; possibly indicating that at least one component of the stimulus used did indeed match a function of the stereotypy, and that satiation had occurred. On the other hand, no trend was maintained for the two VT unmatched sequences in which one set of proportions produced higher rates of stereotypy than did baseline (as would be expected if an unmatched competing stimulus did indeed establish the reinforcing effects of stereotypy through deprivation) and the other set produced lower rates than did baseline (which wouldn't have been predicted by any theory discussed in this paper).

Figure 10 shows Lars' results. When comparing the VT matched and Control sequence test to average baseline proportions for Lars, a trend very similar to the final two VT matched sequences for Greg can be seen in which the proportions derived from the VT matched sequences produced lower rates of stereotypy in the test conditions than did the control sequences. It is possible that these data indicate that at least one component of the test stimulus matched at least one property of reinforcement maintaining the target stereotypy. The VT unmatched sequences for Lars produced more stable data than that produced for Greg. These proportions are almost identical to those of their corresponding control proportions; indicating that the reinforcing product of the target behavior was not established to be more reinforcing due to the response deprivation caused by the unmatched competing

stimulus. Whether or not the reinforcement provided during the VT-unmatched schedule increased the behavioral persistence, of the stereotypy cannot be determined because an effective disruptor was not used in the test component.

Figure 13 displays test to average baseline proportional ratios for Lars' second series of tests. The proportions shown on this graph are very interesting because they contradict the results of Lars' first persistence tests. The original measurements showed that the test to baseline proportions of the matched sequences were consistently lower for both Greg and Lars. This measurement, however, shows the matched sequences being consistently higher than their corresponding control sequences. The results for the VT unmatched sequences are less contradictory, but still surprising. In Lars' first measurement, the unmatched and control proportions were almost indistinguishable. The first unmatched and control proportions of the second measurement are also indistinguishable (both sequences produced proportions of zero). However, during the second sequence, the proportions produced by the unmatched sequence were lower than those produced by the control sequence. This result is not predicted by either theory discussed in this paper.

Whatever effects that matched and unmatched stimuli had on the motivating operations in place for stereotypy during this experiment must have been small. Each participant had only three 30-s access periods to the stimuli during the VT component. It is possible that only a more molecular analysis than the one used to interpret the data generated in the current study could detect whether or not the stimuli did indeed have an effect on the motivation operating on the target stereotypy. Figures 14-16 display VT to average baseline proportional ratios. The X-axis

displays the sequence being represented, and the Y-axis displays the specific sequence VT component divided by the average of the first and final sequence baseline components.

In Greg's tests, VT-access sequences were consistently lower than control sequences regardless of the type of the competing stimulus used (matched or unmatched). In Lars' first series of tests, there is no observable trend for either of the VT-access sequences. For both matched and unmatched stimuli, one proportion displayed more stereotypy than its control, and the other displayed less stereotypy than its control. In Lars' second test series, both VT unmatched sequences produced higher proportions of stereotypy than did their corresponding control sequences; suggesting that response deprivation did occur during access periods. The VT matched sequences showed un-differentiable results, again showing one sequence displaying lower proportions of stereotypy than its control, and the other displaying higher proportions. One possible explanation for this inconsistency is that there was a two and a half week lapse in time in which the lead experimenter had no interaction with the participant (as opposed to the 3 to 4 times per week that had been typical for the previous two months). Directly after this lapse the second VT-Matched sequence was run, and the participant was given no time to re-acquaint himself with the experimenter. During the first baseline of this sequence, the participant spent the majority of the time requesting hugs and smelling the hair of the experimenter; driving rates of stereotypy to atypically low rates and bringing down the average baseline rates. By the second component (VT-Matched) the novelty of the experimenter had worn off and the participant ignored him almost completely;

rates of stereotypy subsequently returned to more typical levels. Had this not occurred, the proportions of the second VT-Matched sequence may have also been lower than its control, perfectly demonstrating the effects of motivating operations predicted by Rapp.

Because of the various confounds and inconsistency on the data, no definitive conclusions can be drawn. However, it might be helpful to look at how the rates of stereotypy reacted to the matched and unmatched stimuli within the VT components alone to detect the effects of satiation and deprivation. A within-component analysis might show more consistencies in the data and provide less opportunity for procedural and environmental confounds.

Figures 17-19 display the results of a within component analysis in which the 30-s preceding (pre) and following (post) each access period within the VT sequences and their corresponding control sequences were scored for stereotypy. The post-baseline was then divided by the pre-baseline to determine proportional ratios of pre and post access periods to measurements of stereotypy taken during comparable times with no periods of access to competing stimuli.

The X-axes show the session and within session component number. The Y-axes show the proportion of post- to pre-baseline rates of responding, where “1” would display a perfect correlation. In all three test series’, no differentiation can be observed between post- matched and unmatched reinforcement rates of stereotypy and corresponding rates in control conditions.

One confound to this observation is that many times a pre-access baseline rate was zero and therefore could not be used to make a ratio (because zeros cannot be put

into the divisor of an equation). Any series that shows less than three consecutive data points contains such cases. Near zero numbers put into the divisor of the equations for the data points not included in the line graph would yield ratios much higher than any others graphed. Thus, missing data points can be assumed to be well above any other graphed.

Another confound is that no direct comparison can be made between the graphs produced in this experiment with those produced during any other experiment because there was no disruption present during the "test components" (post-baselines) used to derive the ratios seen.

General Discussion

One interesting observation derived from this study was that the effects of behavioral persistence could not be seen when the highly preferred test stimulus did not also effectively compete with stereotypy. Once the highly preferred test stimulus also competed, the effects of behavioral persistence became much more apparent, and appeared to affect the target behavior similarly regardless of whether or not it had been previously exposed to a matched or an unmatched competing stimulus.

The results of this study are too variable to draw any definitive conclusions about the questions asked in the introduction of this paper. While the results of the effects of unmatched highly preferred/competing stimuli were highly inconclusive during experiment 1, the results for the effects of matched highly preferred/competing stimuli both Greg and Lars indicated that satiation had occurred and that the matched stimuli served as an abolishing operation for the effects of subsequent stereotypy; supporting the outcomes predicted by the Rapp studies. However, during the second

experiment for Lars the exact same stimuli were used for both the VT matched and VT unmatched components and, the results were the exact opposite than those of the previous experiment. One possible explanation for this might be that there are specific conditions under which the effects of behavioral momentum are activated (e.g., only in the presence of strong disruption). Under these conditions, the effects of motivating operations are less observable due to a more fundamental and powerful behavioral operation. In other words, only in the presence of disruption does behavioral momentum negate the effects of motivating operations. This explanation; however, is flawed and does not fully describe the data taken in experiment 2. According to momentum theory, regardless of the specific properties of the stimulus, if it is indeed a reinforcer, its effects on the persistence of behavior will be constant. The test to average baseline ratios taken in experiment two indicate that the properties of stimuli do indeed differentially affect behavioral persistence, they simply affect it in the exact opposite way than would have been predicted by Rapp.

One confound to this study is the assumption that the stimuli used did indeed match, or not match, the maintaining functions of the target stereotypy. It is possible that the stimuli chosen to match, simply did not match, the maintaining functions. This would help to explain some of the variability identified in our data.

Another flaw with the current design is that there is little to protect against false positives and negatives. The effects of each type of reinforcer were only assessed twice. Using the current methods of interpretation (either matched and unmatched sequences produce higher, or lower, rates of stereotypy than control sequences) there is a 50% chance that rates of stereotypy not controlled by preceding

access to specific types of reinforcement could demonstrate that those types of reinforcement do indeed control it. Future designs should include many more sequences for each type of reinforcement to better control for variability and random confirmations of false positive and negative correlations.

In conclusion, it appears that it is only under specific conditions that the effects of behavioral persistence can be observed. More specifically, a disrupting stimulus must not only be highly preferred, but must also highly compete with stereotypy in order to observe the effects of momentum. Whether or not highly preferred and highly competing matched and unmatched stimuli differentially affect the outcomes of behavioral momentum still have not been determined. In the future, a preference assessment that is better able to determine the actual preference and competing qualities of stimuli should be used. Once highly preferred and highly competing matched and unmatched stimuli can be more confidently secured, many more persistence tests should be run for each quality of reinforcer to more effectively control for false positives and false negatives.

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Diagram Captions

Diagram 1: Component organization within each sequence

Diagram 1:

Sequence A

Baseline	Baseline	Test	Baseline

Sequence B

Baseline	VT Matched	Test	Baseline

Sequence C

Baseline	VT Unmatched	Test	Baseline

Figure Captions

Figure 1: Greg's rocking stereotypy functional analysis

Figure 2: Lars' hand stereotypy functional analysis

Figure 3: Greg's preference assessment

Figure 4: Lars' preference assessment

Figure 5: Greg's persistence tests

Figure 6: Lars' first series of persistence tests

Figure 7: Greg's persistence tests separated by quality of reinforcer

Figure 8: Lars' first persistence tests separated by quality of reinforcer

Figure 9: Test to average baseline proportions for Greg

Figure 10: Test to average baseline proportions for Lars' first persistence tests

Figure 11: Lars' second series of persistence tests

Figure 12: Lars' second persistence tests separated by quality of reinforcer

Figure 13: Test to average baseline proportions for Lars' second persistence tests

Figure 14: VT to average baseline proportions for Greg

Figure 15: VT to average baseline proportions for Lars' first persistence tests

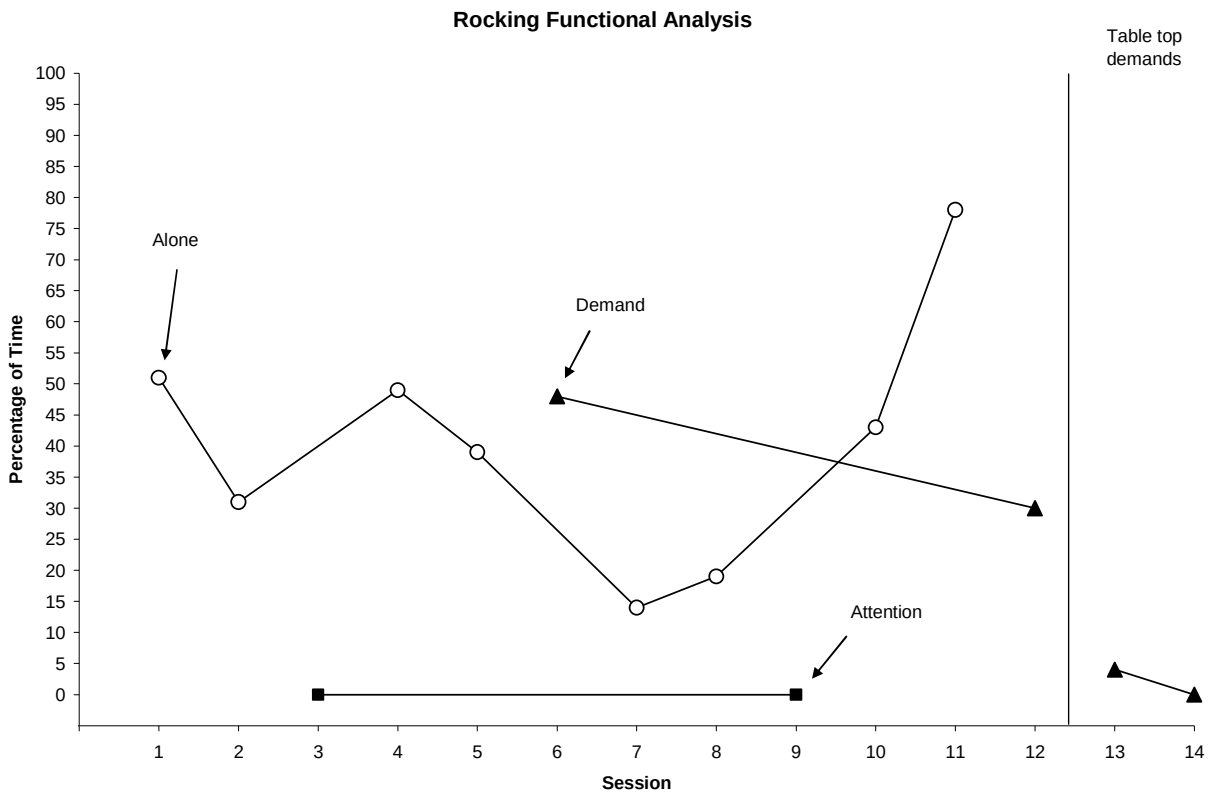
Figure 16: VT to average baseline proportions for Lars' second persistence tests

Figure 17: Within VT component analysis for Greg

Figure 18: Within VT component analysis for Lars' first persistence tests

Figure 19: Within VT component analysis for Lars' second persistence tests

Figure 1:


Rocking Functional Analysis
Table top demands
Alone
Demand
Attention
Percentage of Time
Session
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
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13
14

Figure 2:

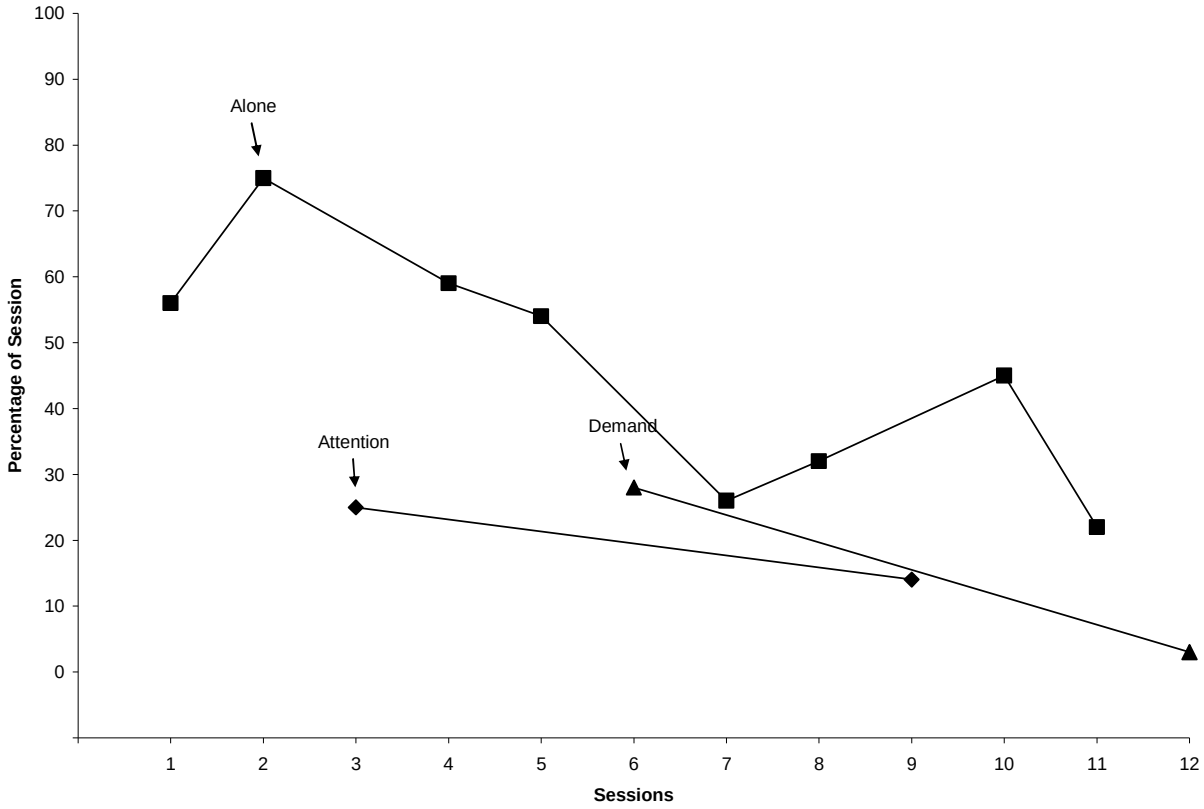

100
90
80
70
60
50
40
30
20
10
0
Percentage of Session
Alone
Attention
Demand
1
2
3
4
5
6
7
8
9
10
11
12
Sessions

Figure 3:

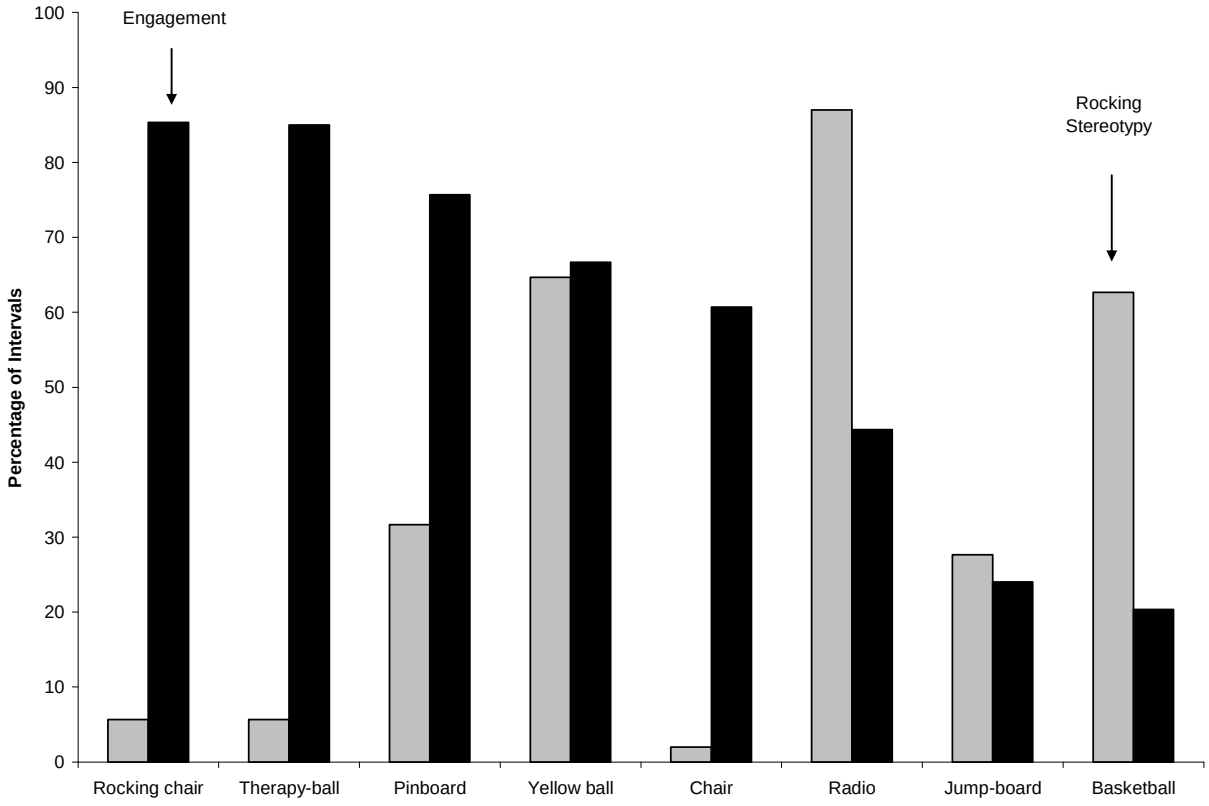

Engagement
Rocking
Stereotypy
Percentage of Intervals
100
90
80
70
60
50
40
30
20
10
0
Rocking chair
Therapy-ball
Pinboard
Yellow ball
Chair
Radio
Jump-board
Basketball

Figure 4:

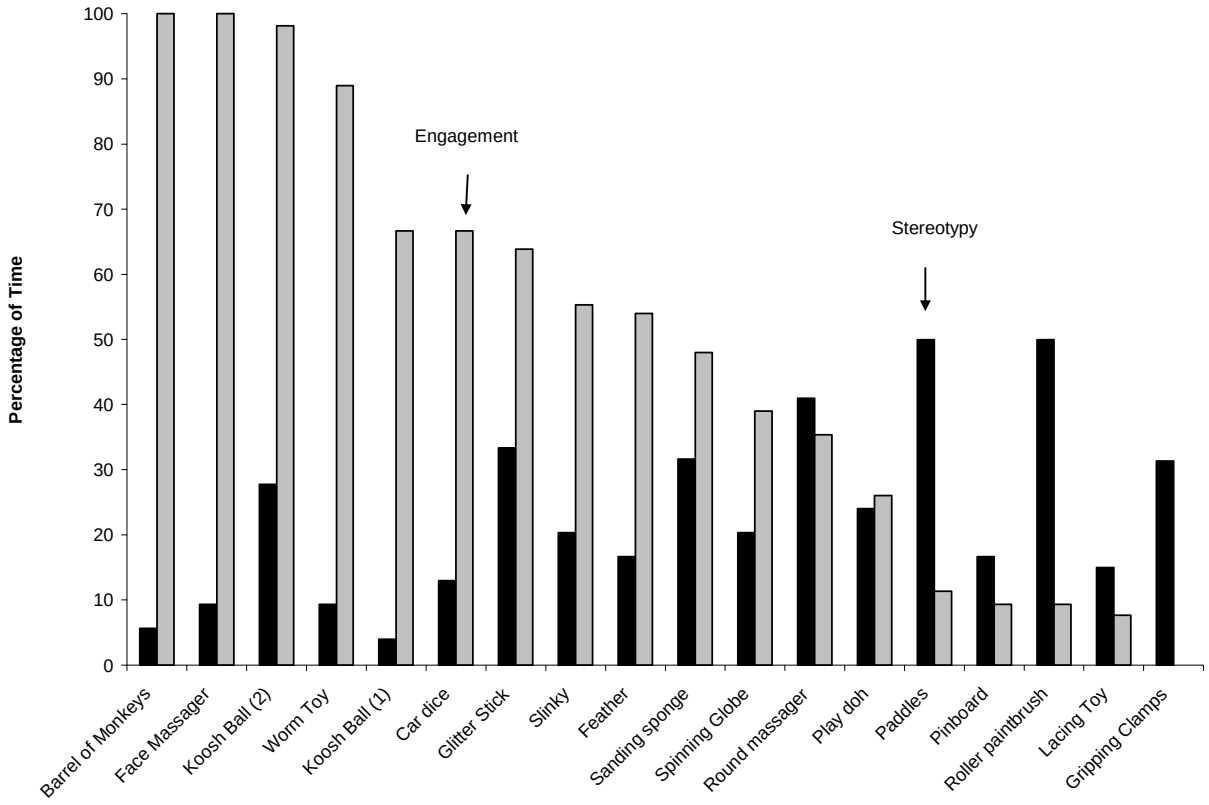
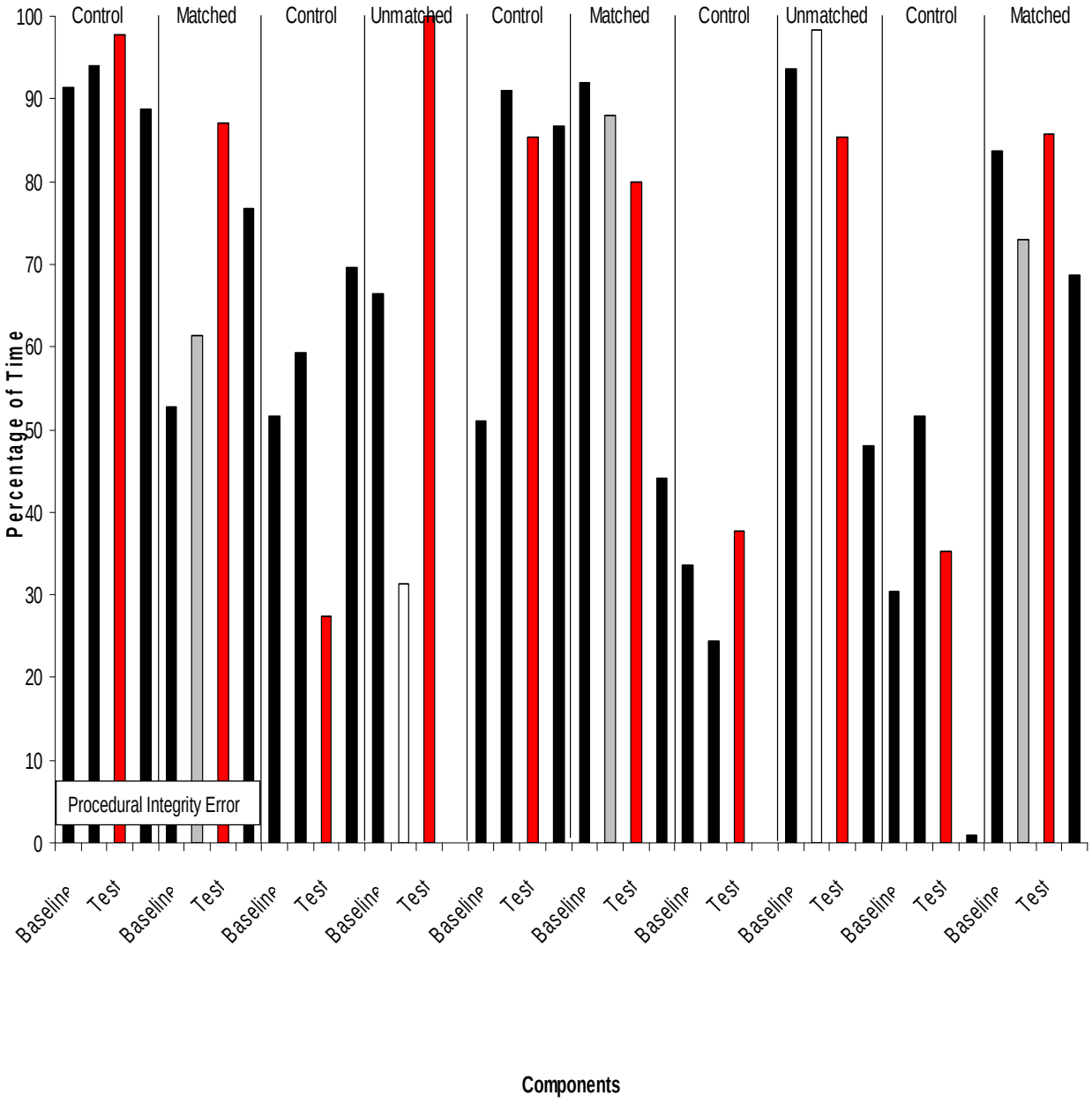
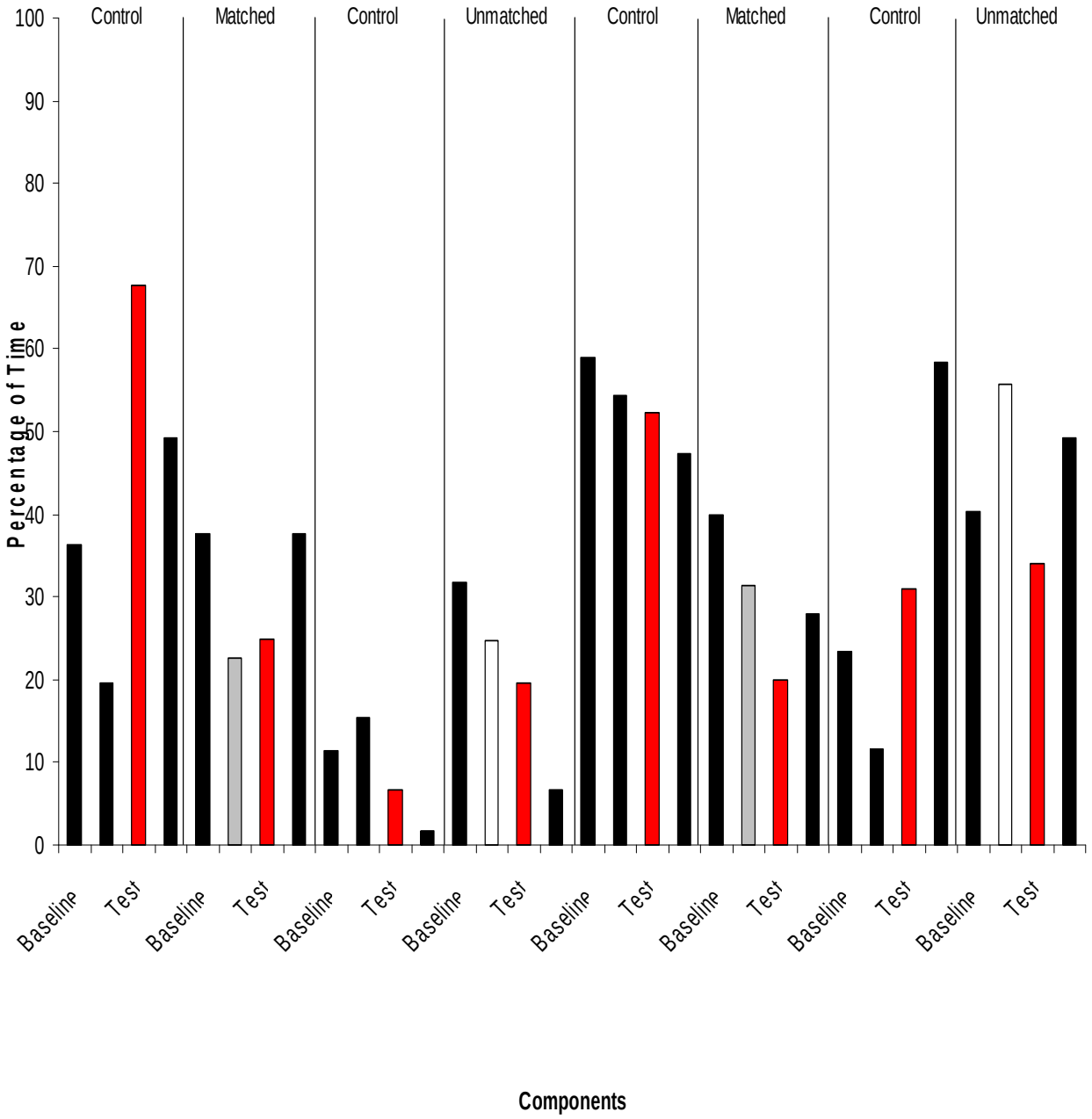

Percentage of Time
100
90
80
70
60
50
40
30
20
10
0
Engagement
Stereotypy
Barrel of Monkeys
Face Massager
Koosh Ball (2)
Worm Toy
Koosh Ball (1)
Car dice
Glitter Stick
Slinky
Feather
Sanding sponge
Spinning Globe
Round massager
Play doh
Paddles
Pinboard
Roller paintbrush
Lacing Toy
Gripping Clamps

Figure 5:



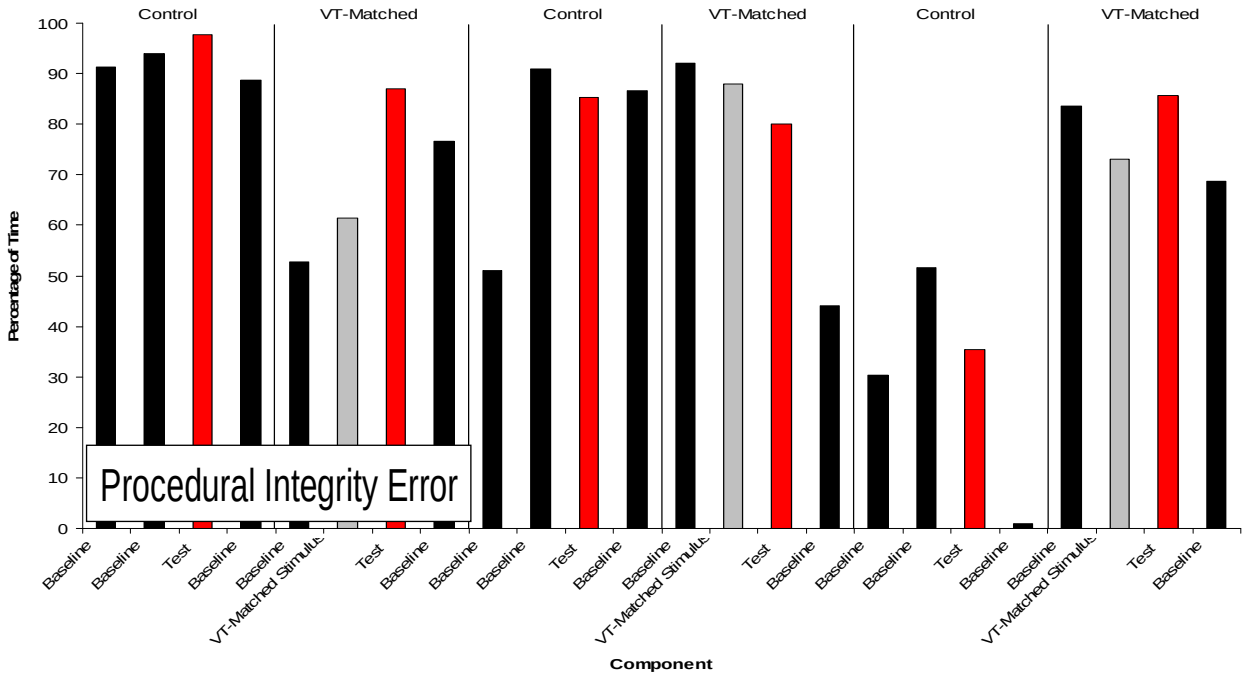
Greg

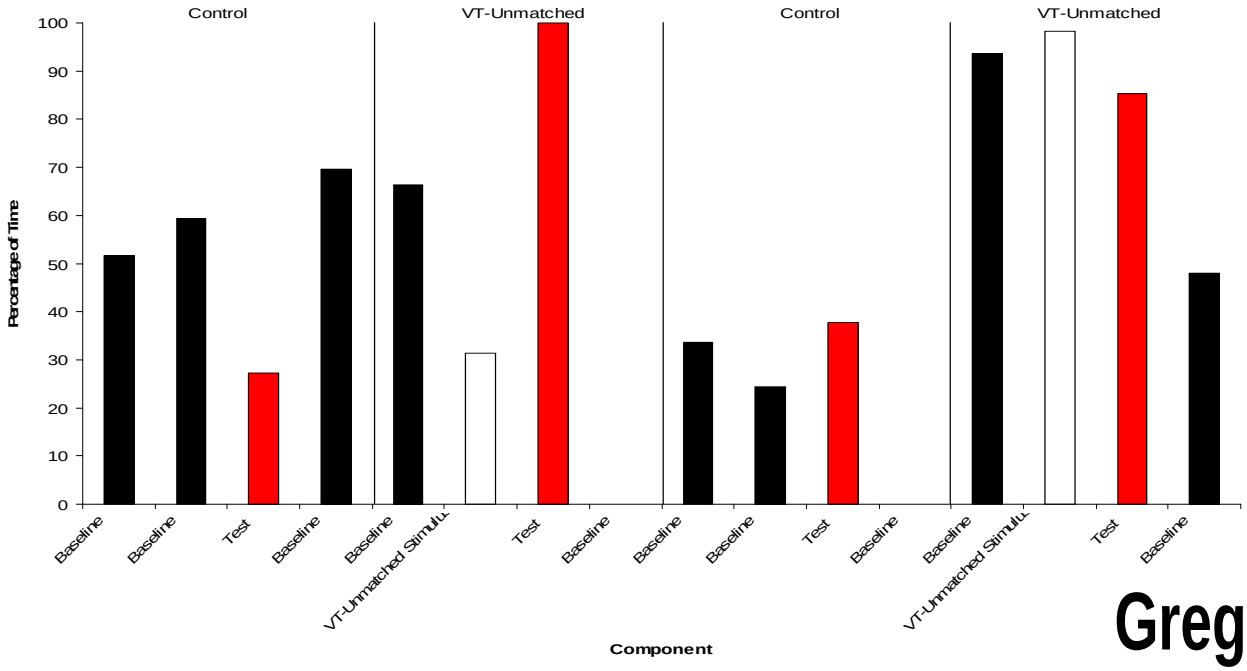
Figure 6:



Lars 1

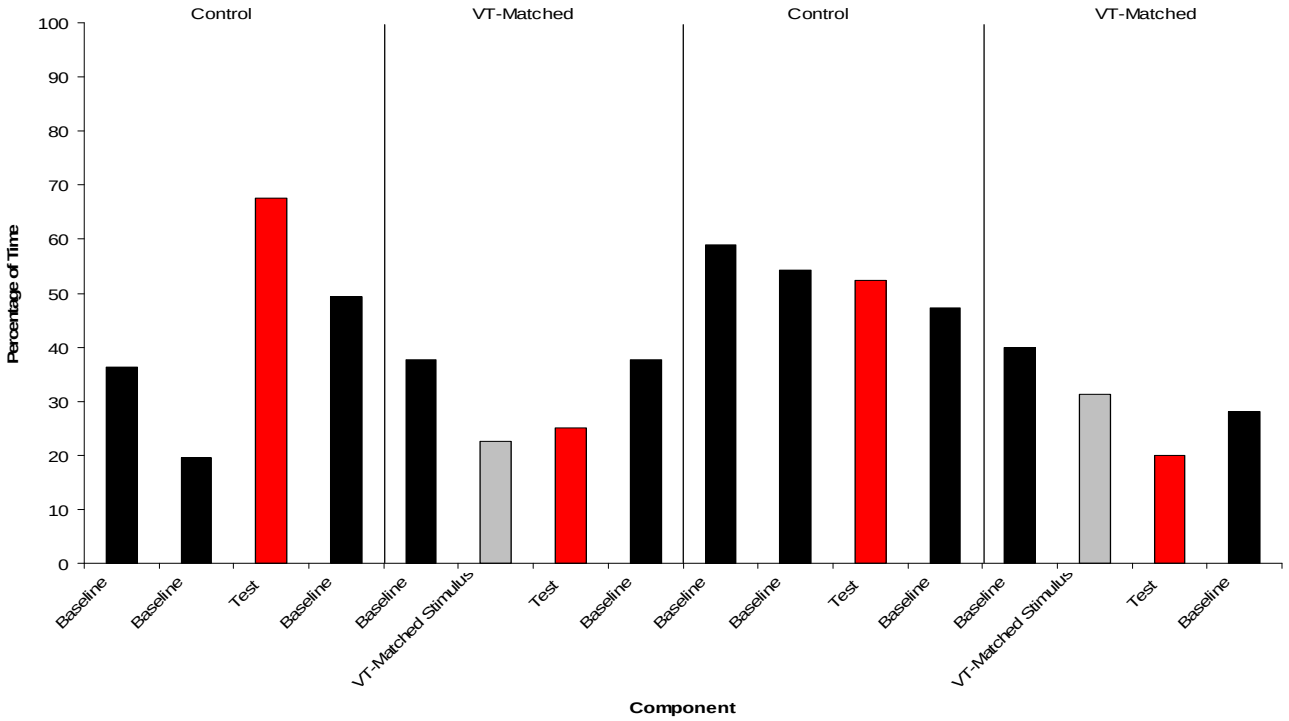
Figure 7:

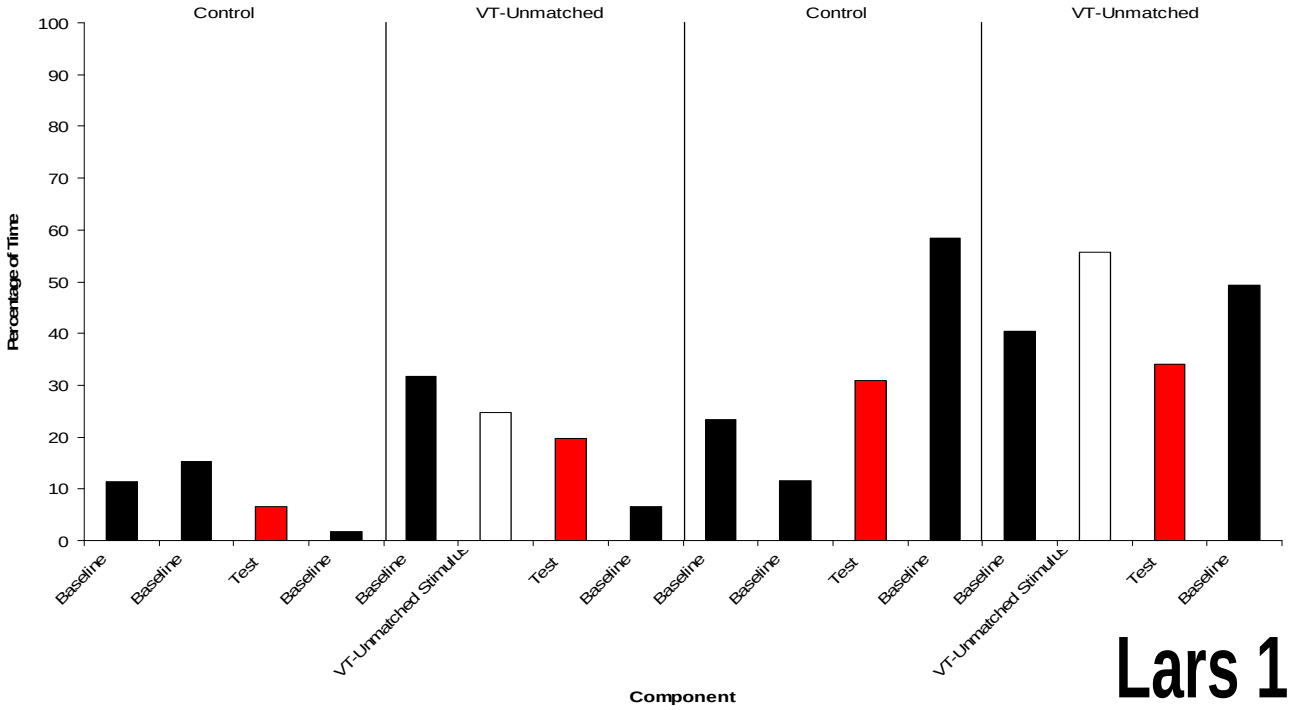




Greg

Figure 8:





Lars 1

Figure 9:

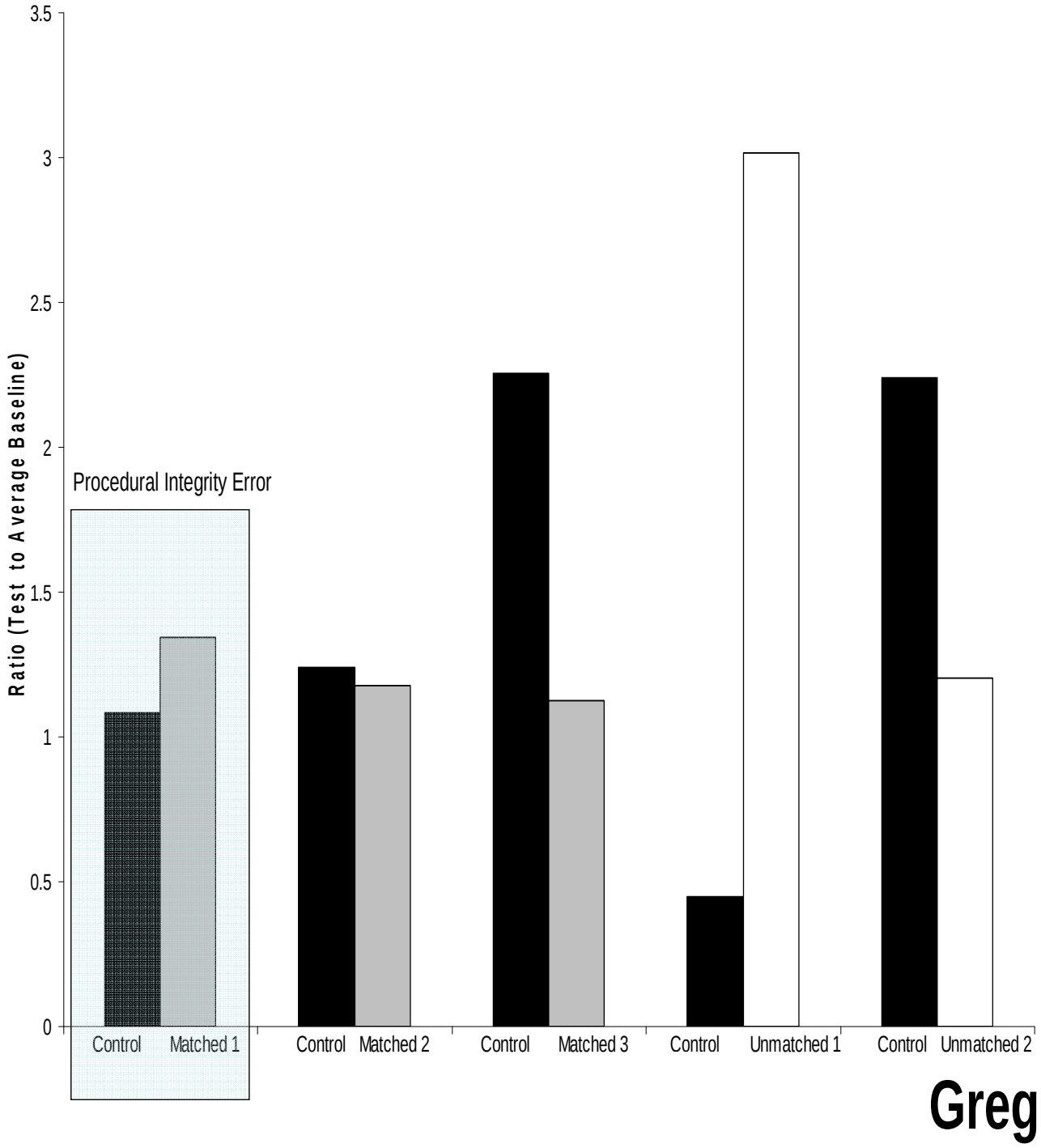
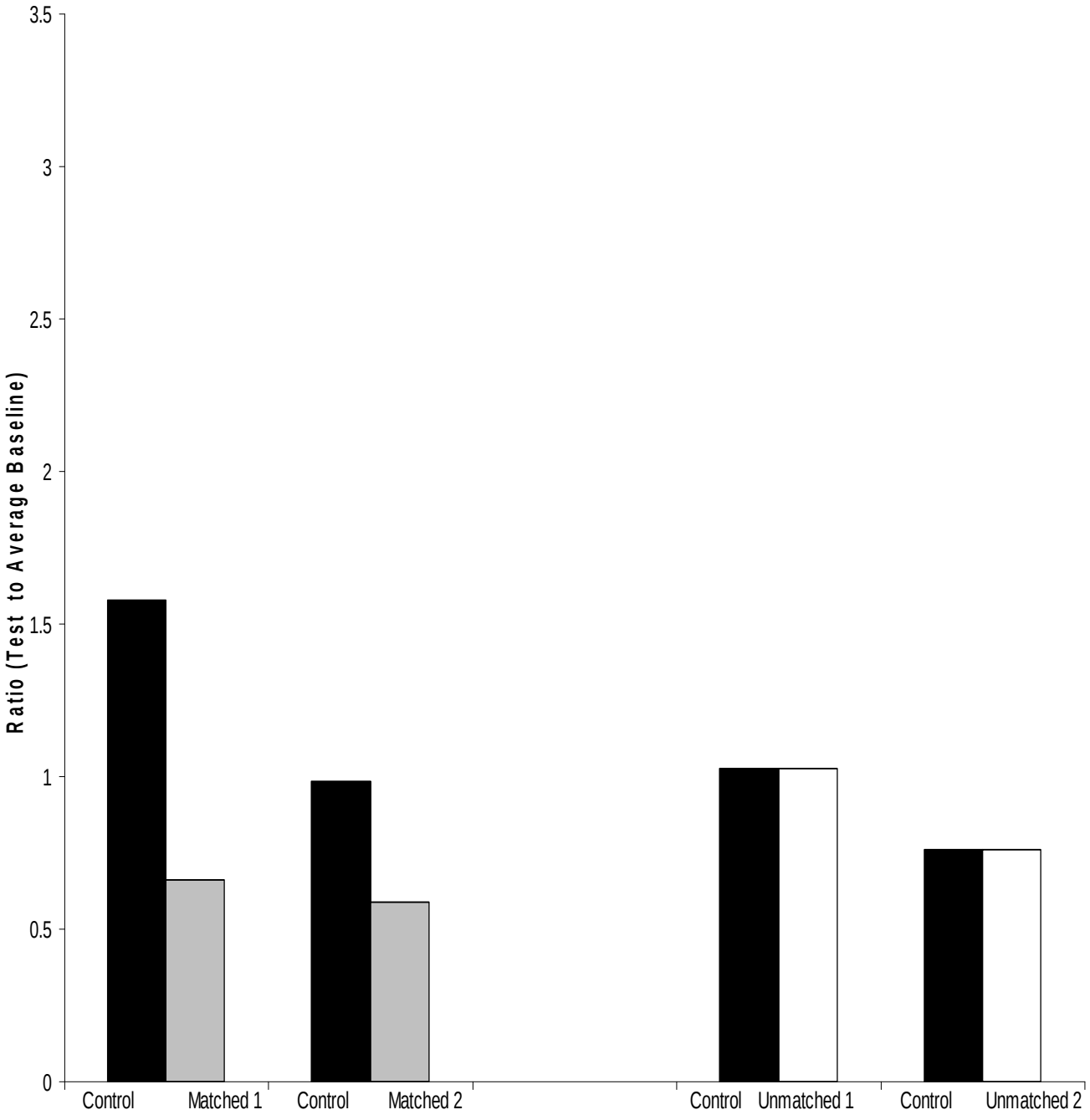
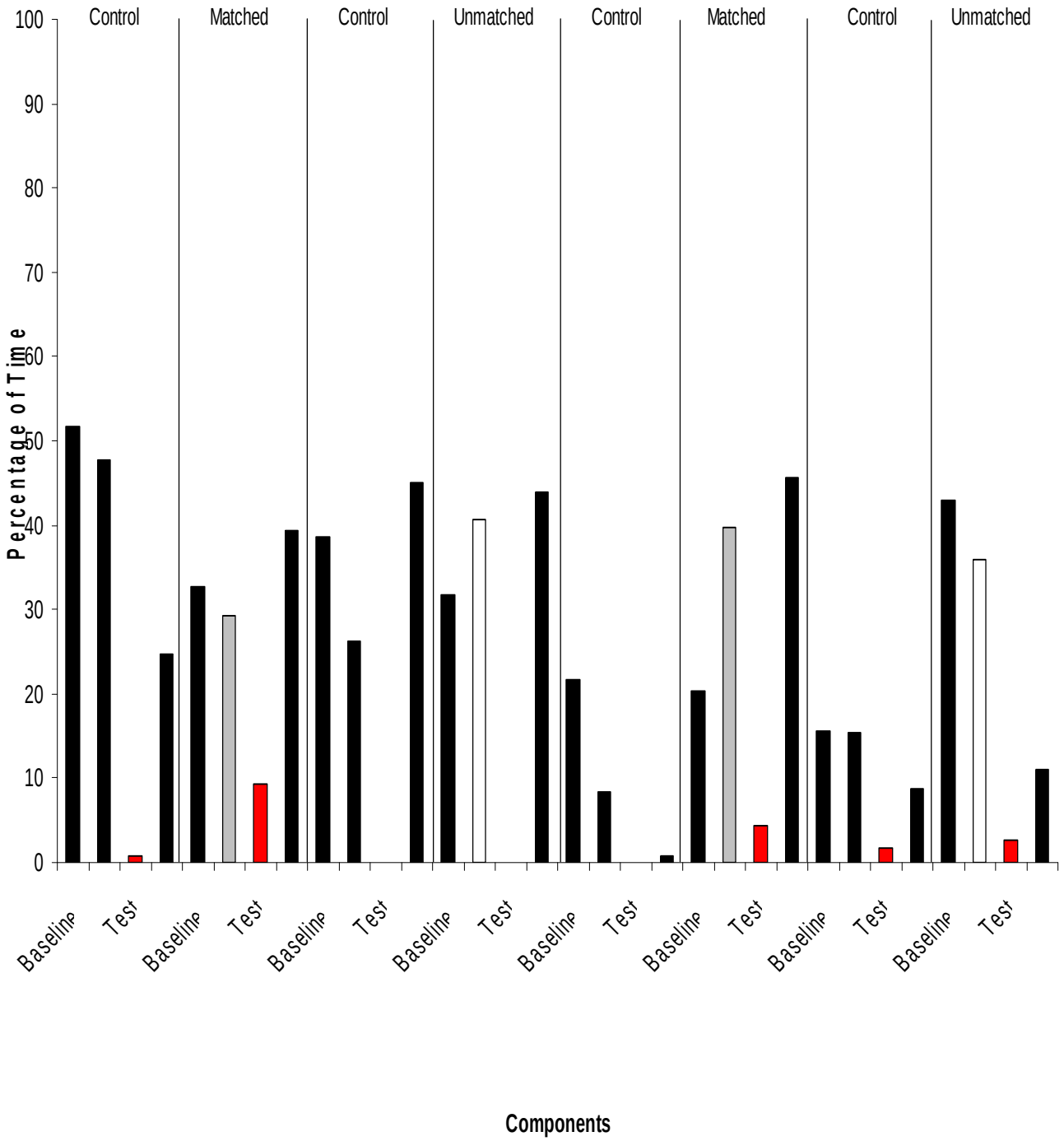

3.5
3
2.5
2
1.5
1
0.5
0
Ratio (Test to Average Baseline)
Procedural Integrity Error
Control
Matched 1
Control
Matched 2
Control
Matched 3
Control
Unmatched 1
Control
Unmatched 2
Greg

Figure 10:



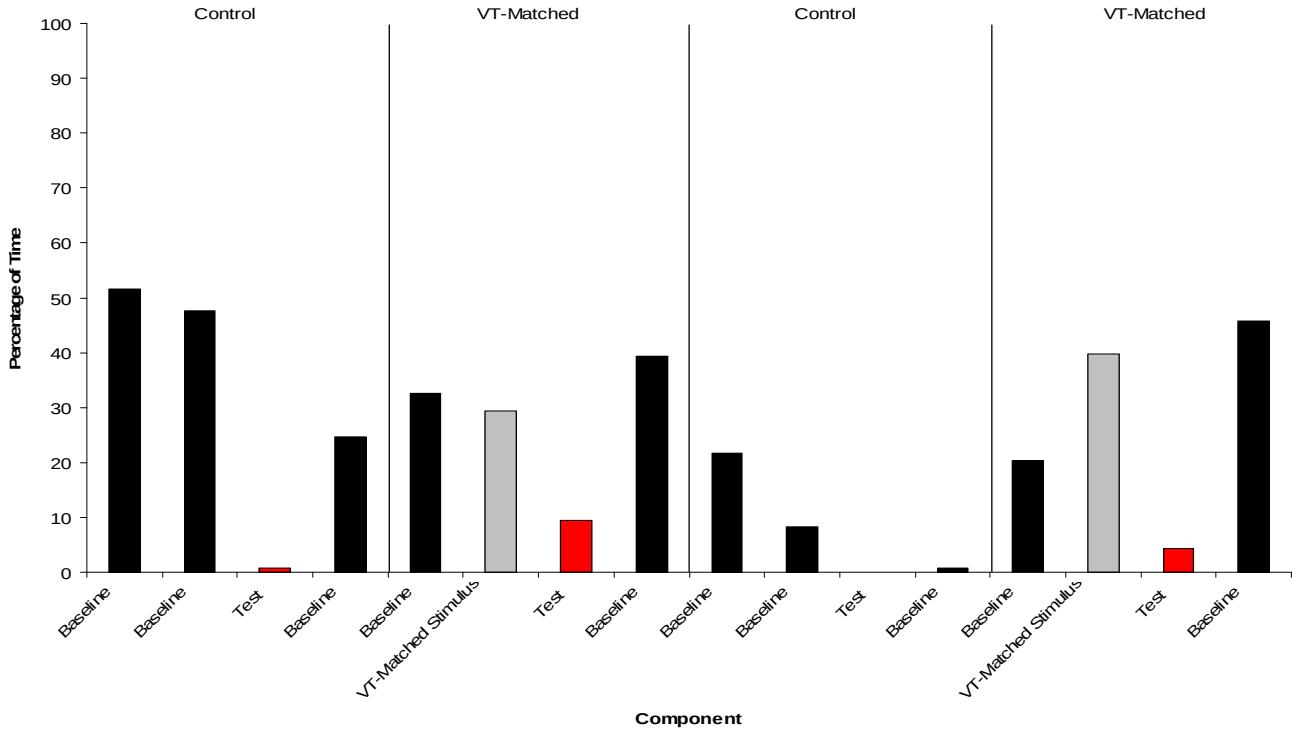
Lars 1

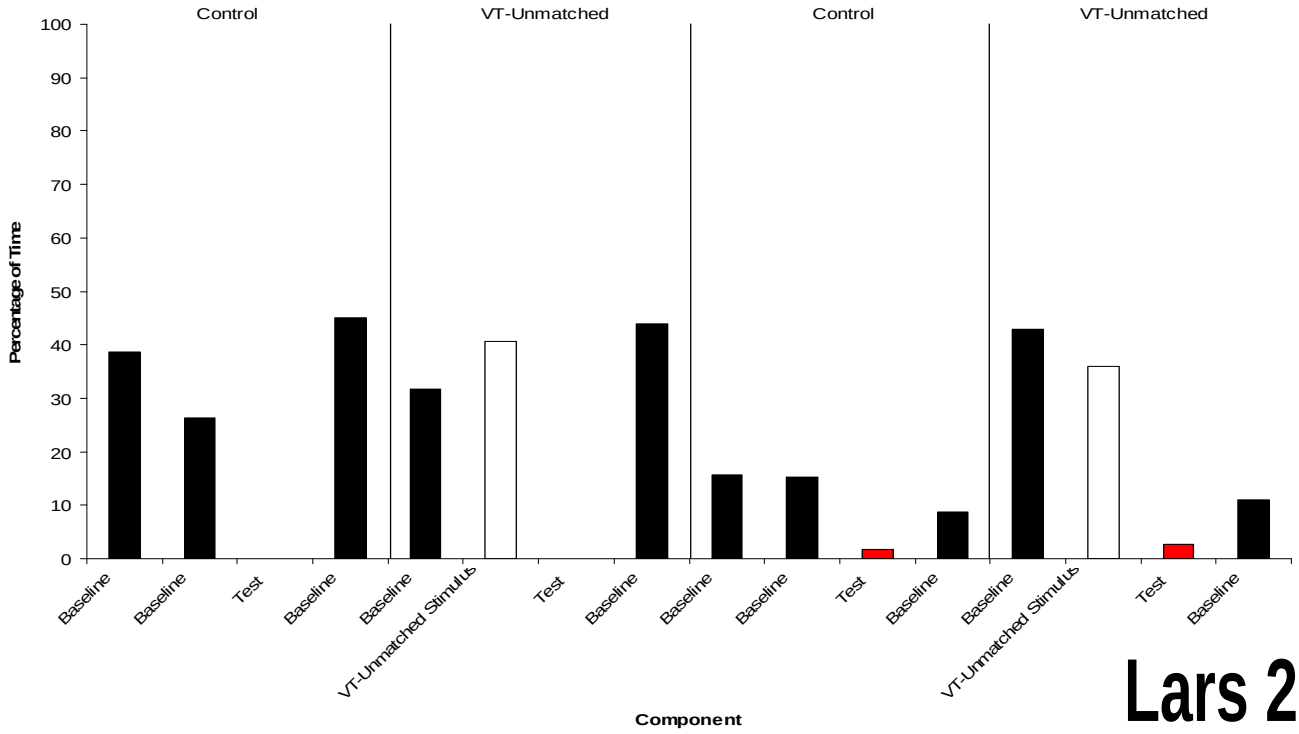
Figure 11:



Lars 2

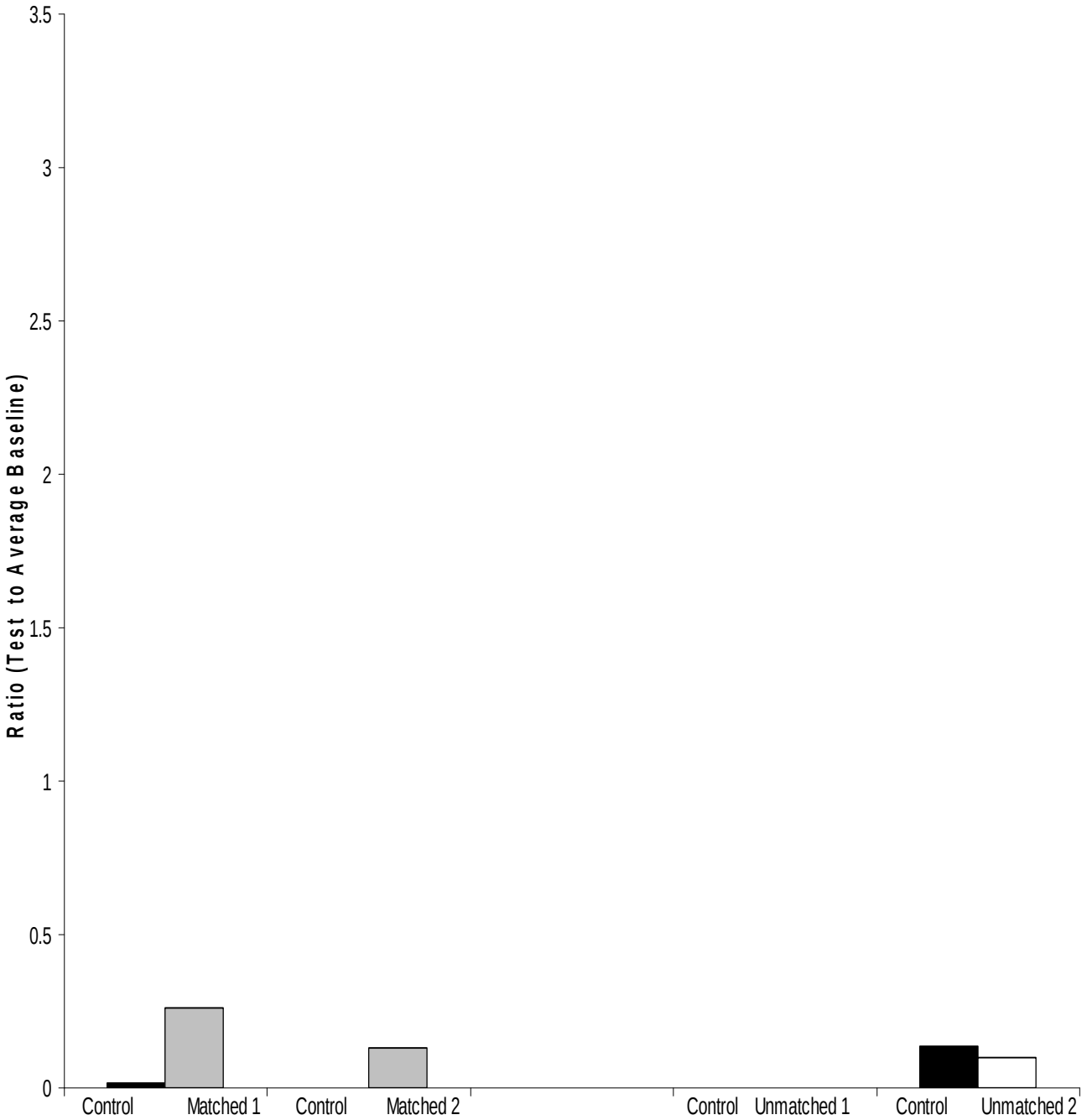
Figure 12:





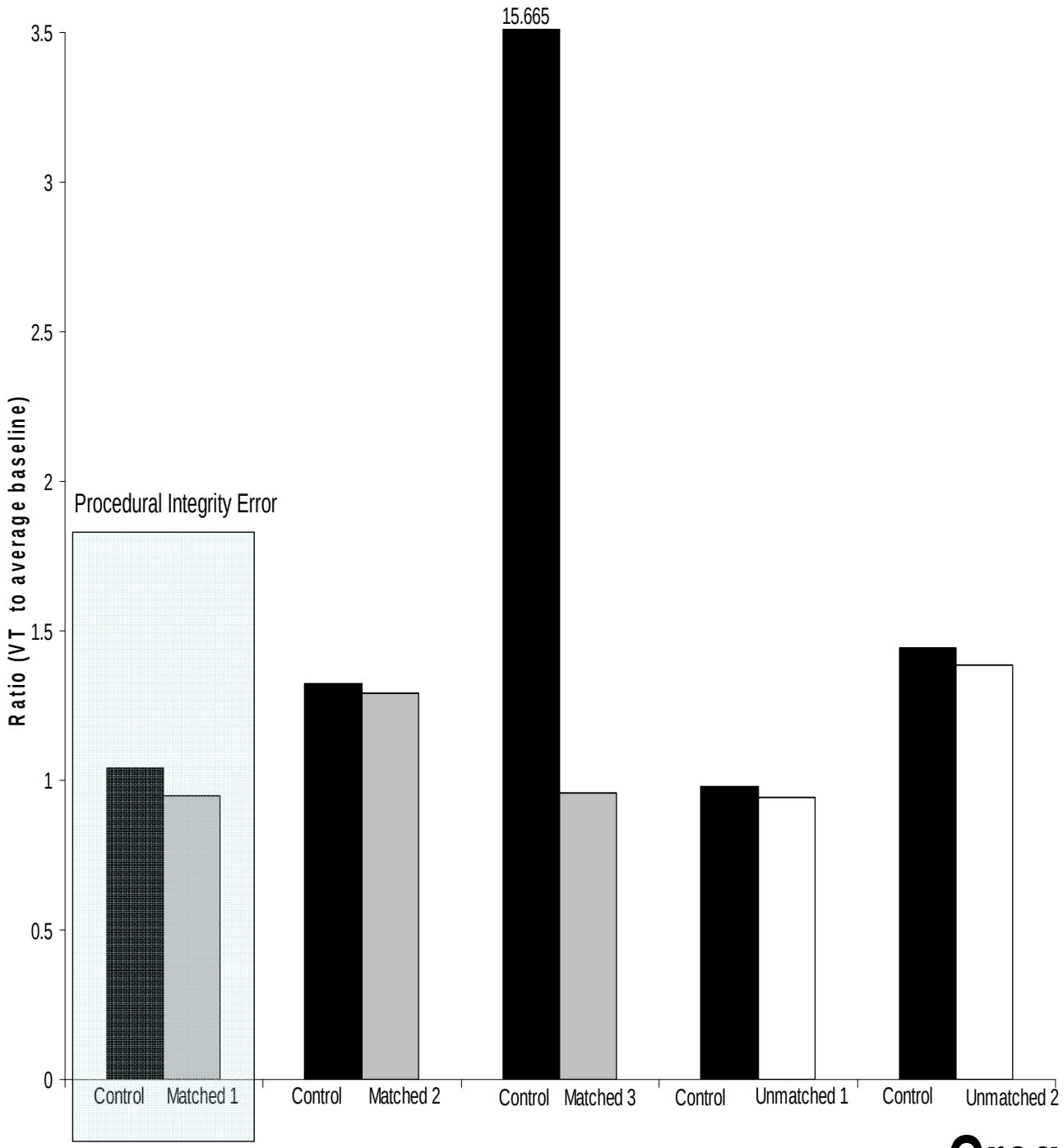
Lars 2

Figure 13:



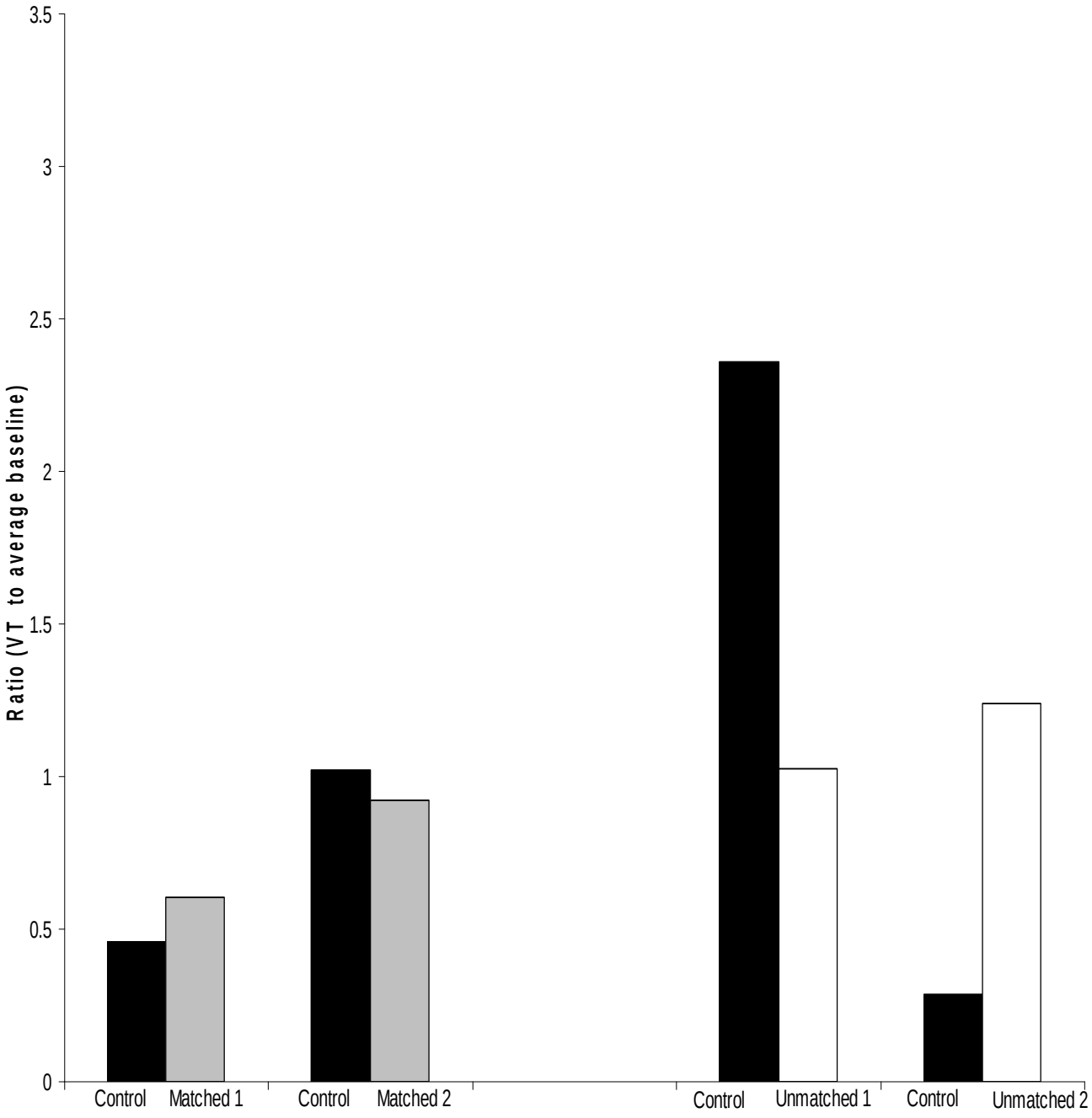
Lars 2

Figure 14:



Greg

Figure 15:



Lars 1

Figure 16:

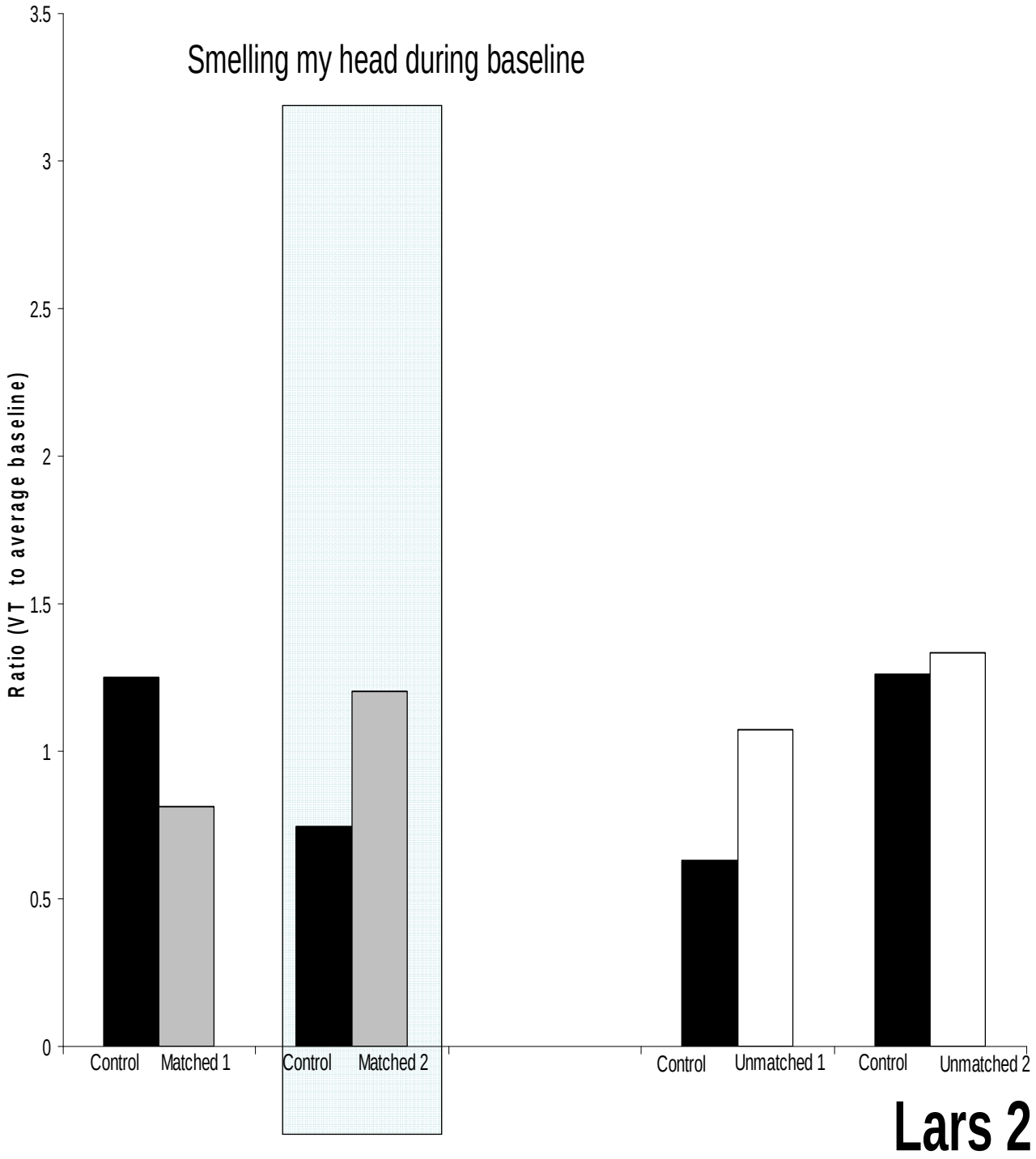
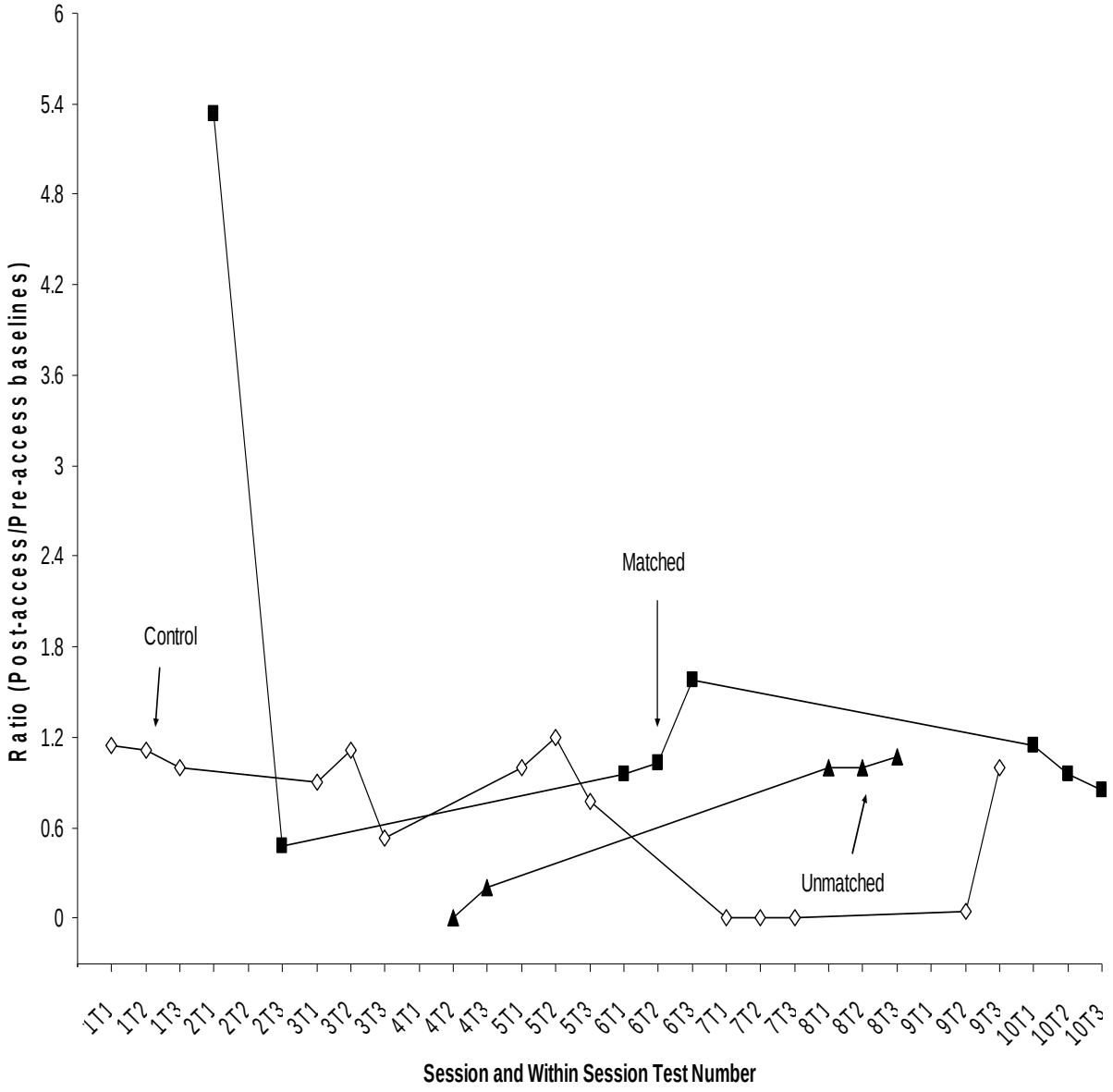
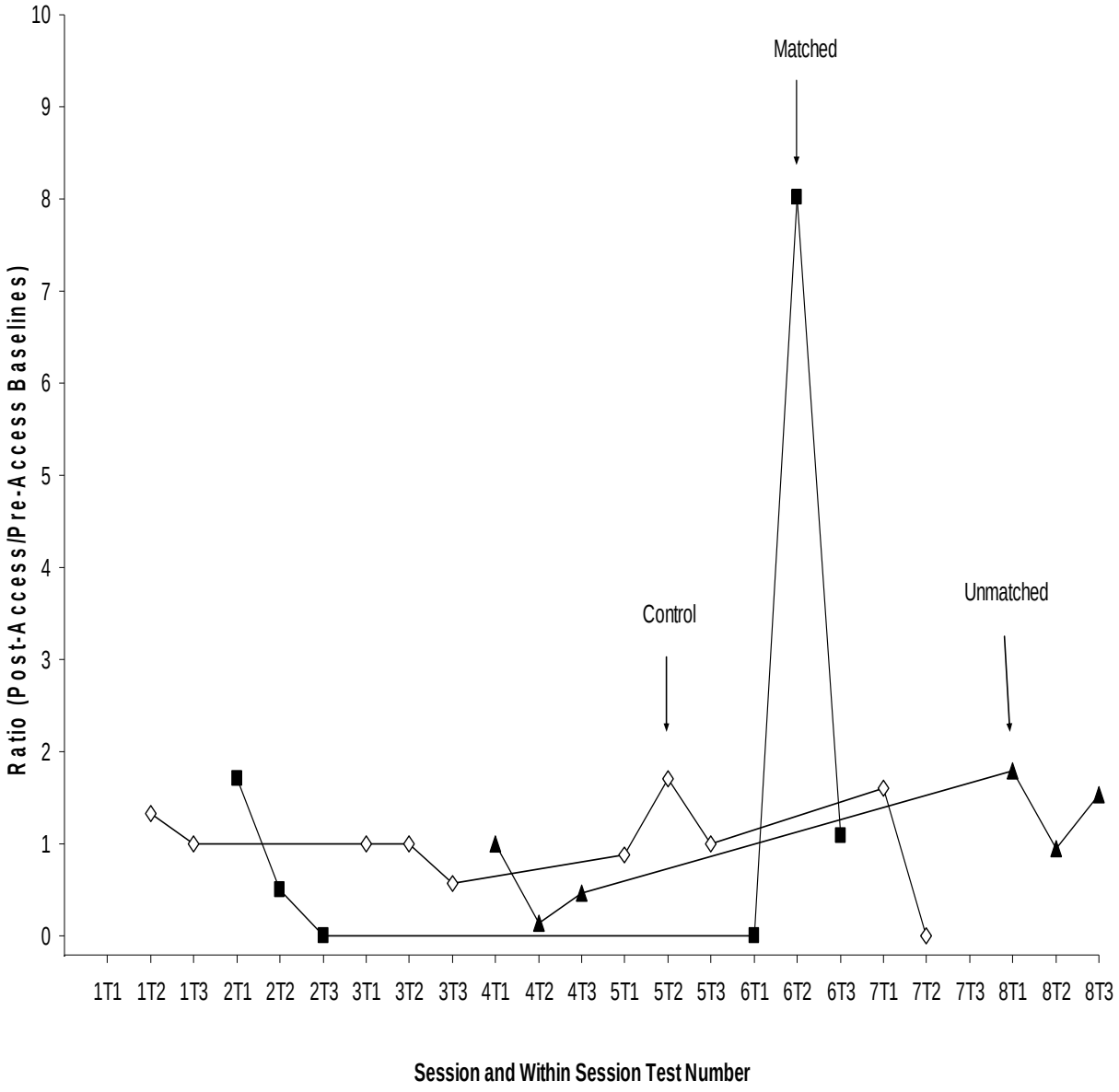

Smelling my head during baseline
Ratio (VT to average baseline)
3.5
3
2.5
2
1.5
1
0.5
0
Control
Matched 1
Control
Matched 2
Control
Unmatched 1
Control
Unmatched 2
Lars 2

Figure 17:



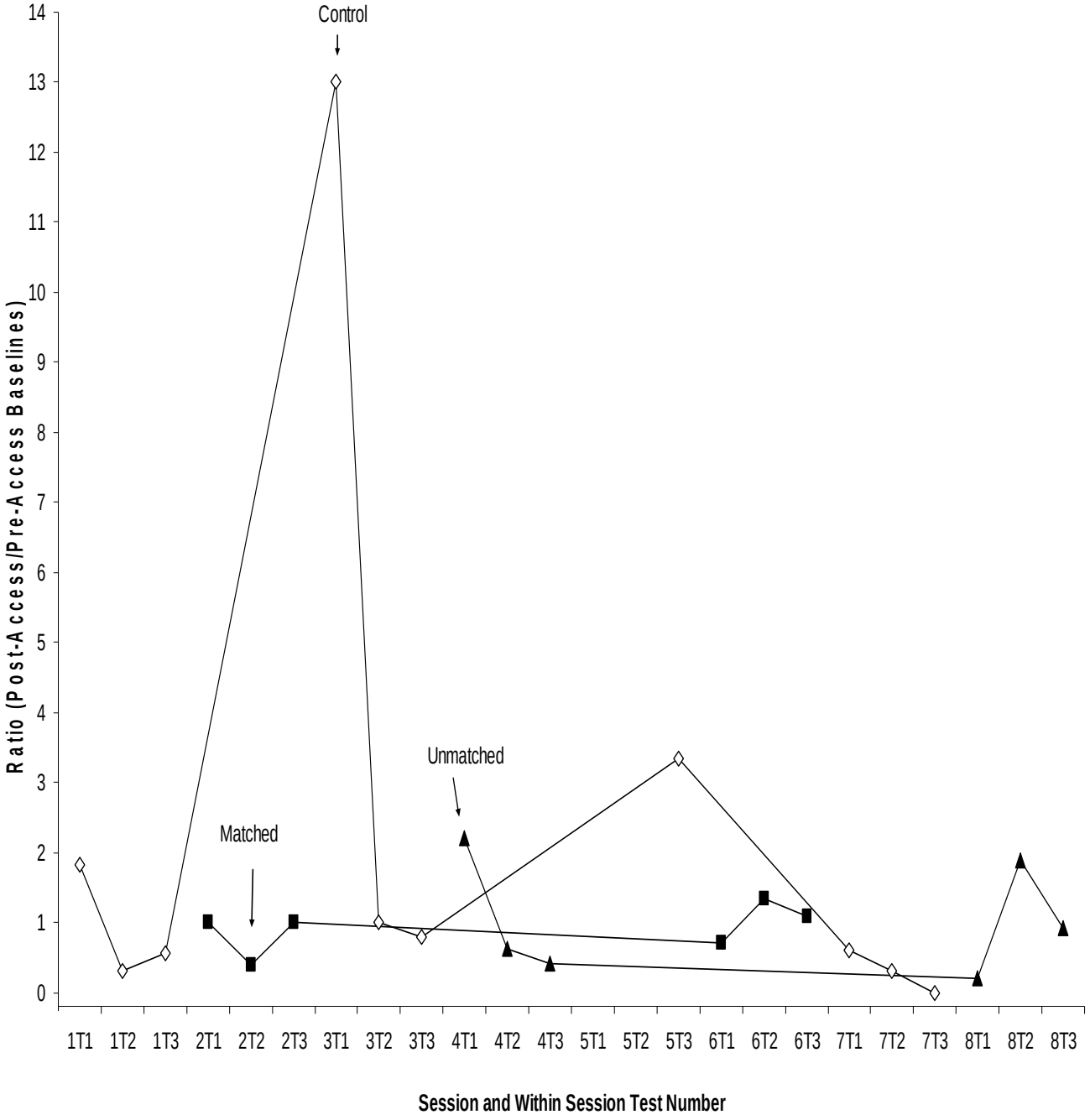
Greg

Figure 18:



Lars 1

Figure 19:



Lars 2