Treatment intensity and the effect of repetition priming on naming performance in individuals with anomia

Clinical aphasia researchers have demonstrated efficacy across both phonological and semantic treatment approaches for individuals with anomia (e.g., Boyle, 2004; Kendall, et al., 2008; Renvall et al., 2007). As this research continues to emerge, clinicians are gaining invaluable knowledge about the ideal treatment approach to select for each client or treatment context. Simultaneously, neuroscience research is progressing rapidly and clinical researchers have begun to manipulate principles of neuroplasticity to optimize treatment paradigms (e.g., Kleim & Jones, 2008; Kurland, et al., 2010; Ludlow et al., 2008). One variable that has gained a substantial amount of attention is treatment intensity; participants who receive a greater number of treatment sessions improve to a greater degree than those who receive conventional aphasia therapy (e.g., Brady, et al., 2012; Meinzer et al., 2011). Research protocols have yet to be designed that systematically manipulate intensity variables to estimate the amount of treatment required to best facilitate improved language skills in persons with aphasia (PWA). That is, a majority of the treatment intensity evidence comes from studies that were designed to assess the efficacy of specific treatment approaches. The purpose of this study was to directly investigate the influence of intensity and repetition on naming performance, while simultaneously removing the issue of treatment approach. A repetition priming paradigm was used to assess the influence of treatment intensity and stimulus dosage on the acquisition and maintenance of picture naming accuracy for PWA.

Research Design and Methods

A single subject ABA design with replication across seven subjects with chronic aphasia investigated the acquisition and maintenance of naming for trained pictures and generalization to untrained pictures using a repetition priming paradigm. One healthy control also participated. Participants were enrolled in a training protocol that involved repeated exposure to pictures of concrete nouns and their names, along with repeated attempts to name those pictures. Independent variables included stimulus dosage (i.e., 1- vs. 4-trials/session) and training variables (i.e., trained vs. untrained pictures). Lexical variables including word frequency and word length were controlled. The dependent variable was response accuracy for PWA and response time for the control.

Seven adults with chronic aphasia, and one healthy non-brain injured control participant enrolled in the study. Persons with aphasia were between six months and 21 years post-stroke, with no evidence of subsequent neurological decline. PWA presented with mild to severe symptoms of expressive language impairment with no evidence of a concomitant severe to profound apraxia of speech or severe to profound dysarthria. Participants did not exhibit previous or concomitant neurological, psychiatric, or substance abuse disorders. Hearing and vision were corrected to normal. All participants were native speakers of American English and were between the ages of 41-90 years of age. See table 1 for a summary of the participants' profiles.

During the baseline period (phase A), response accuracy was repeatedly measured for trained and untrained pictures across four probe sessions. During the training phase (phase B), up to 15 treatment sessions were administered 2-3 times per week. During training sessions, trained pictures (1- or 4-trials/session) were accompanied by the spoken and written name of the

depicted item. Training probes were administered after every third training session and before every fourth training session. Treatment was then withdrawn; three probes were administered at least six weeks following completion of the B phase to assess maintenance of trained stimuli. All participants completed all phases of the protocol; however, each participant's delivery schedule was unique, resulting in variable overall dosage (see table 2).

Data Collection and Analysis

The experimenter transcribed each response verbatim and judged for accuracy using a binary +/- coding system for all sessions. One hundred percent of the recordings of the probe sessions were reviewed by the experimenter to ensure accurate transcription of participants' responses. The experimenter coded the transcribed responses for accuracy. Errored responses were assigned an error code according to a modified taxonomy adapted from the Philadelphia Naming Test (Roach, Schwartz, Linebarger, Martin, & Bochetto, 1988).

Descriptive statistics including means, ranges, and standard deviations for response accuracy (and response time for the control participant) were calculated for each participant, across each phase of the experimental protocol relative to the independent variables. Line graphs for response accuracy (and reaction time for the control participant) were produced for each participant, depicting performance across phases of the experimental protocol for trained vs. untrained items and 1- vs. 4-trials/session items. Visual analysis of the line graphs was used to interpret level, trend, variability, and onset of training effects.

Effect sizes were calculated (Beeson and Robey, 2006) to assess the magnitude of change relative to baseline performance for trained and untrained items and for stimulus dosage. Busk and Serlin's *d* was used to compare mean performance during the maintenance phase to the mean performance during the baseline phase, relative to the variance observed during the baseline phase.

Trained undergraduate research assistants, uninvolved in data collection, serve as reliability judges for this protocol. Judges listen to 100% of the recorded probe data for all participants. Judges are blind to the original transcriptions and accuracy judgments. Cohen's Kappa will be used to calculate inter-judge reliability for the binary accuracy judgment between the experimenter and reliability judge.

Results

Response accuracy (and response time for the control) was plotted across baseline, training, and maintenance phases for both trained and untrained items. For trained items, response accuracy was also plotted across baseline, training, and maintenance phases relative to stimulus dosage. All participants demonstrated increased response accuracy for trained items relative to untrained items immediately following initiation of the training (*B*) phase (see figures 1-8). Response accuracy increases for these trained items persisted through the maintenance phase for five of the seven participants, thus far. Overall, the stimulus dosage variable for trained items did not consistently influence response accuracy for the participants (see figures 9-16). Effect sizes ranged from small to medium for trained items; effect sizes were insignificant for untrained items (see table 3).

Discussion and Future Directions

The primary goal of this study was to document the effect of repetition priming in PWA as measured by response accuracy during picture-naming, in an effort to optimize treatment intensity for anomia rehabilitation. Results suggest that mere repetition delivered in a systematic and highly intensive manner can significantly improve and maintain picture naming accuracy for PWA across severity and aphasia classification.

The stimulus dosage manipulation presented did not consistently impact response accuracy during the training phase. However, a more consistent pattern emerged when the maintenance phase of the protocol was taken into consideration. Four of the five participants who have completed the maintenance phase of the protocol demonstrated larger effect sizes for the 4-trial/session items than the 1-trial/session items, relative to the baseline phase. One participant demonstrated equal effect sizes for both the 1- and 4-trial/session items, relative to the baseline phase. The magnitude of the effect size varied across participants relative to stimulus dosage, suggesting that the influence that stimulus dosage has on response accuracy warrants further investigation across a larger group of participants. Analysis of training session data is also warranted to document the change in error patterns during the acquisition phase of the protocol.

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Tables

Table 1.
Participant Profiles

	P1	P2	P3	P4	P5	P6	P7	Control
Age	90	47	76	78	61	70	67	53
Gender	Female	Female	Female	Female	Female	Male	Male	Female
Months Post Onset of CVA	6	42	18	8	22	10	240	n/a
CVA Type	Ischemic	Hemorrhagic	Hemorrhagic	Ischemic	Ischemic	Ischemic	Hemorrhagic	n/a
CVA Location	Left MCA	Left Temporal Lobe	Left Basal Ganglia	Left MCA	Left MCA	Left MCA	Left Hemisphere, unspecified	n/a
Premorbid Handedness	Right	Right	Right	Right	Right	Right	Right	Right
WAB-R Aphasia Quotient	73.9/100	60.2/100	82.8/100	54.1/100	76.2/100	37.1/100	66.5/100	n/a
WAB-R Aphasia Classification	Anomic	Wernicke's	Anomic	Conduction	Anomic	Global	Broca's	n/a
Boston Naming Test	10/60	5/60	27/60	12/60	28/60	DNT*	27/60	n/a
Raven's Progressive Matrices	18/36	36/36	20/36	18/36	34/36	14/36	26/36	35/36
Apraxia Battery for Adults	No apraxia	No apraxia	No apraxia	DNT*	Mild apraxia	Moderate apraxia	Moderate Apraxia	n/a
Beck Depression Inventory- II	3/63	10/63	18/63	7/63	25/63	8/63	2/63	n/a
Visual Agnosia	No Evidence	No Evidence	No Evidence	No Evidence	No Evidence	No Evidence	No Evidence	n/a
PALPA	25/60	26/60	50/60	35/60	44/60	0/60	DNT*	n/a

*DNT= Did Not Test

Table 2.
Stimulus Dosage by Participant

	P1	P2	P3	P4	P5	P6	P7	Control
Total Training Sessions	15	6	12	15	13	15	9	9
Total Naming Attempts Trained Items (1 trial)	600	240	480	600	520	600	360	360
Total Naming Attempts Trained Items (4 trials)	2400	960	1920	2400	2080	2400	1440	1440

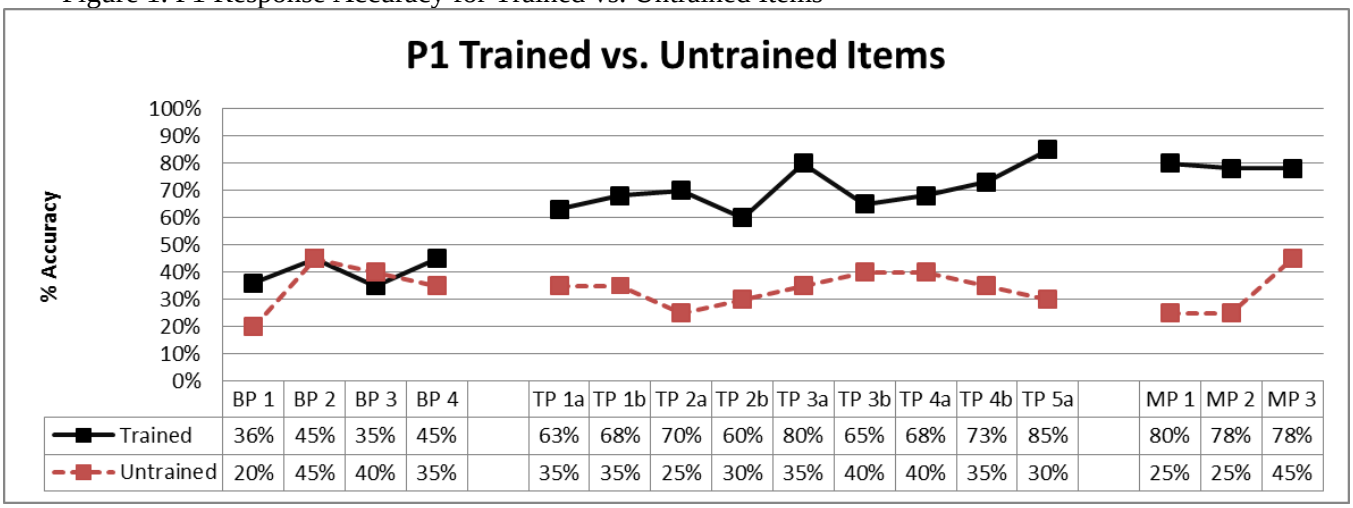
Table 3.
Effect Sizes for Response Accuracy of Trained and Untrained Items and Stimulus Dosage

		P1	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**
Trained Items	**Effect Size**	7.30	4.19	0.12	2.31	*	5.33	*
	Direction of Effect Size	Positive	Positive	Positive	Positive	*	Positive	*
	Size Relative to Benchmark	Medium	Small	No Change	Small	*	Small	*
Untrained Items	**Effect Size**	-0.13	-0.22	-0.92	0.38	*	2.33	*
	Direction of Effect Size	Negative	Negative	Negative	Positive	*	Positive	*
	Size Relative to Benchmark	No Change	No Change	No Change	No Change	*	Small	*
1 trial/session	**Effect Size**	2.89	3.54	-1.5	1.83	*	2.66	*
	Direction of Effect Size	Positive	Positive	Negative	Positive	*	Positive	*
	Size Relative to Benchmark	Small	Small	Small	Small	*	Small	*
4 trials/session	**Effect Size**	19.1	4.53	0.56	2.34	*	2.66	*
	Direction of Effect Size	Positive	Positive	Positive	Positive	*	Positive	*
	Size Relative to Benchmark	Large	Small	No Change	Small	*	Small	*

*Effect size calculations pending completion of maintenance probes (end of January)

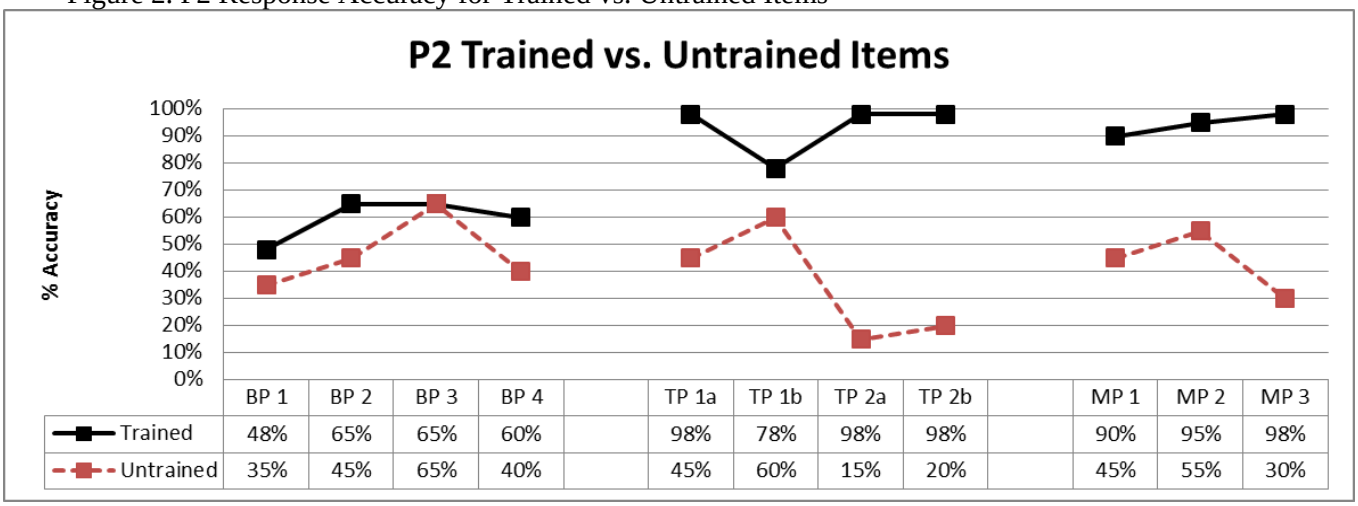
Figures

Figure 1. P1 Response Accuracy for Trained vs. Untrained Items



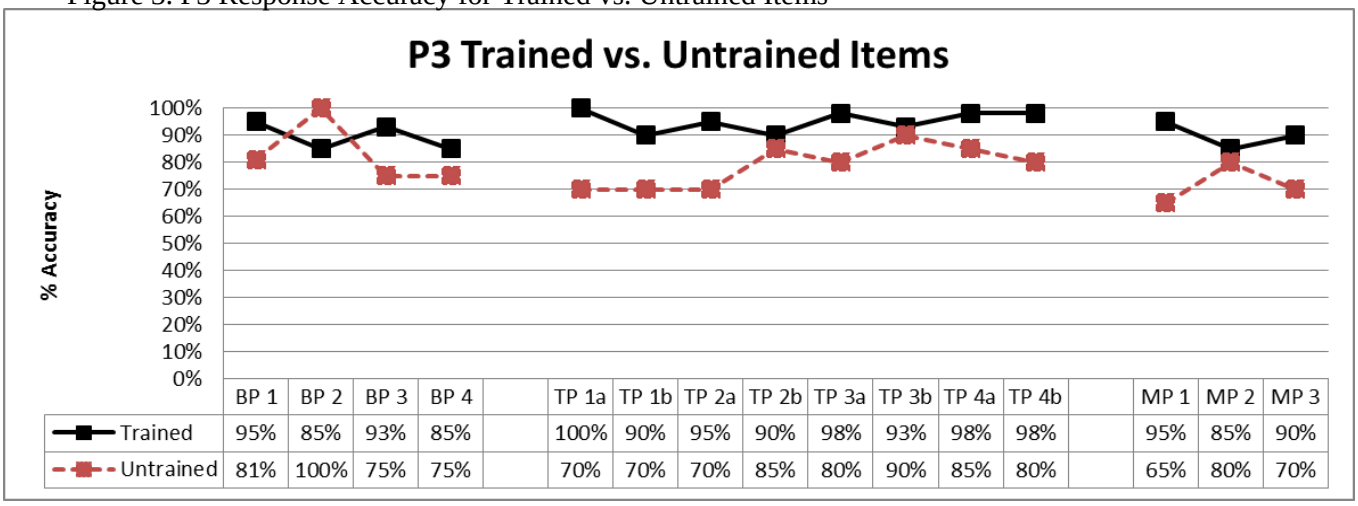
	BP 1	BP 2	BP 3	BP 4	TP 1a	TP 1b	TP 2a	TP 2b	TP 3a	TP 3b	TP 4a	TP 4b	TP 5a	MP 1	MP 2	MP 3
Trained	36%	45%	35%	45%	63%	68%	70%	60%	80%	65%	68%	73%	85%	80%	78%	78%
Untrained	20%	45%	40%	35%	35%	35%	25%	30%	35%	40%	40%	35%	30%	25%	25%	45%

Figure 2. P2 Response Accuracy for Trained vs. Untrained Items



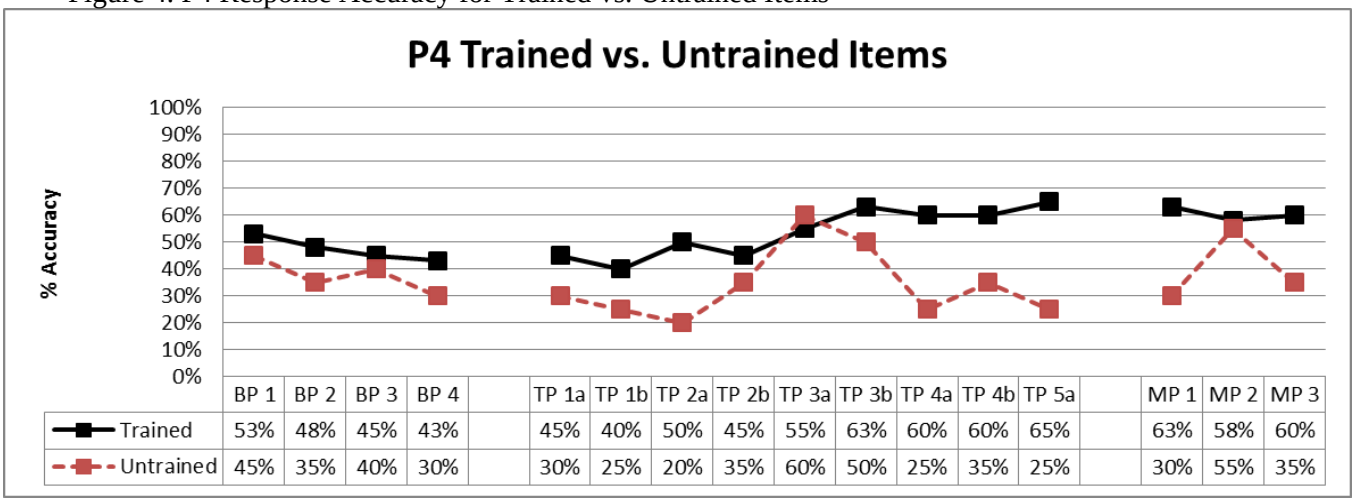
	BP 1	BP 2	BP 3	BP 4	TP 1a	TP 1b	TP 2a	TP 2b	MP 1	MP 2	MP 3
Trained	48%	65%	65%	60%	98%	78%	98%	98%	90%	95%	98%
Untrained	35%	45%	65%	40%	45%	60%	15%	20%	45%	55%	30%

Figure 3. P3 Response Accuracy for Trained vs. Untrained Items



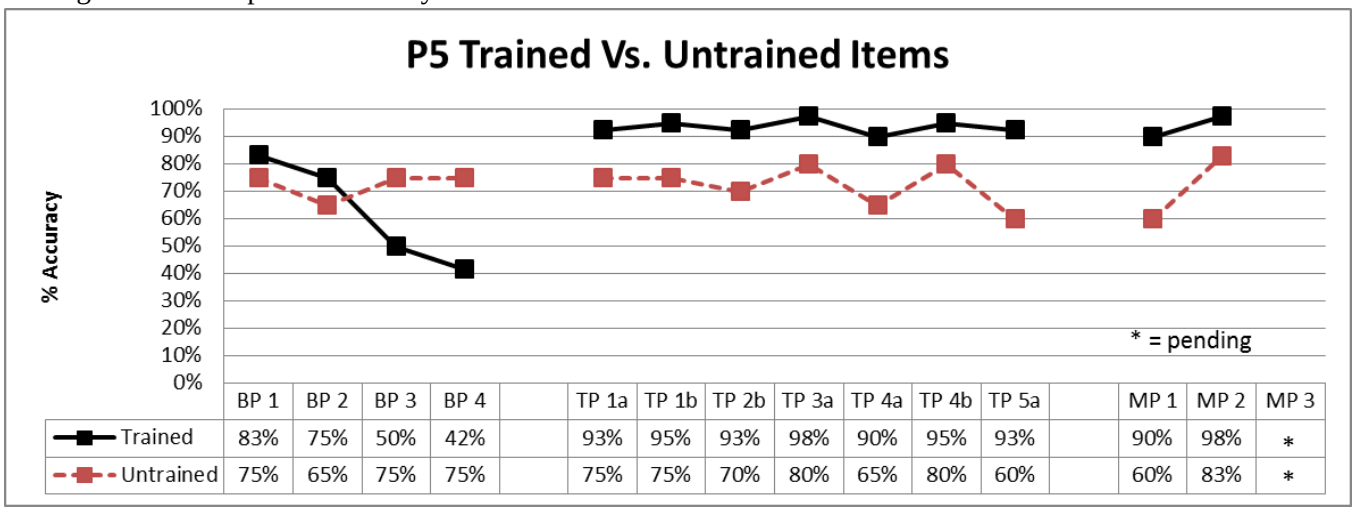
	BP 1	BP 2	BP 3	BP 4	TP 1a	TP 1b	TP 2a	TP 2b	TP 3a	TP 3b	TP 4a	TP 4b	MP 1	MP 2	MP 3
Trained	95%	85%	93%	85%	100%	90%	95%	90%	98%	93%	98%	98%	95%	85%	90%
Untrained	81%	100%	75%	75%	70%	70%	70%	85%	80%	90%	85%	80%	65%	80%	70%

Figure 4. P4 Response Accuracy for Trained vs. Untrained Items



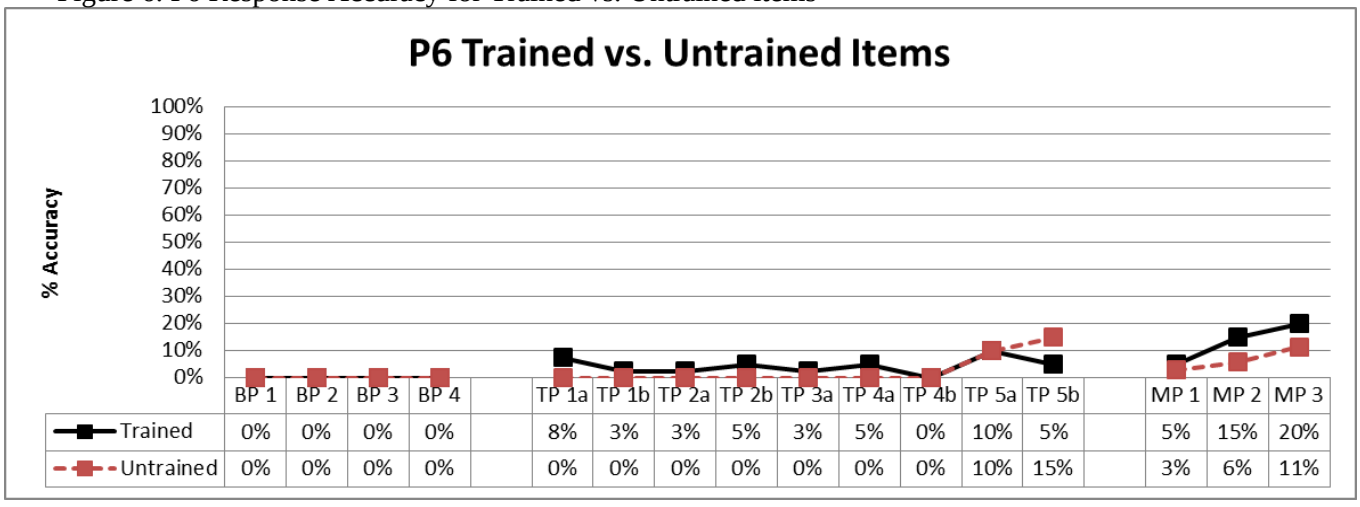
	BP 1	BP 2	BP 3	BP 4		TP 1a	TP 1b	TP 2a	TP 2b	TP 3a	TP 3b	TP 4a	TP 4b	TP 5a		MP 1	MP 2	MP 3
Trained	53%	48%	45%	43%		45%	40%	50%	45%	55%	63%	60%	60%	65%		63%	58%	60%
Untrained	45%	35%	40%	30%		30%	25%	20%	35%	60%	50%	25%	35%	25%		30%	55%	35%

Figure 5. P5 Response Accuracy for Trained vs. Untrained Items



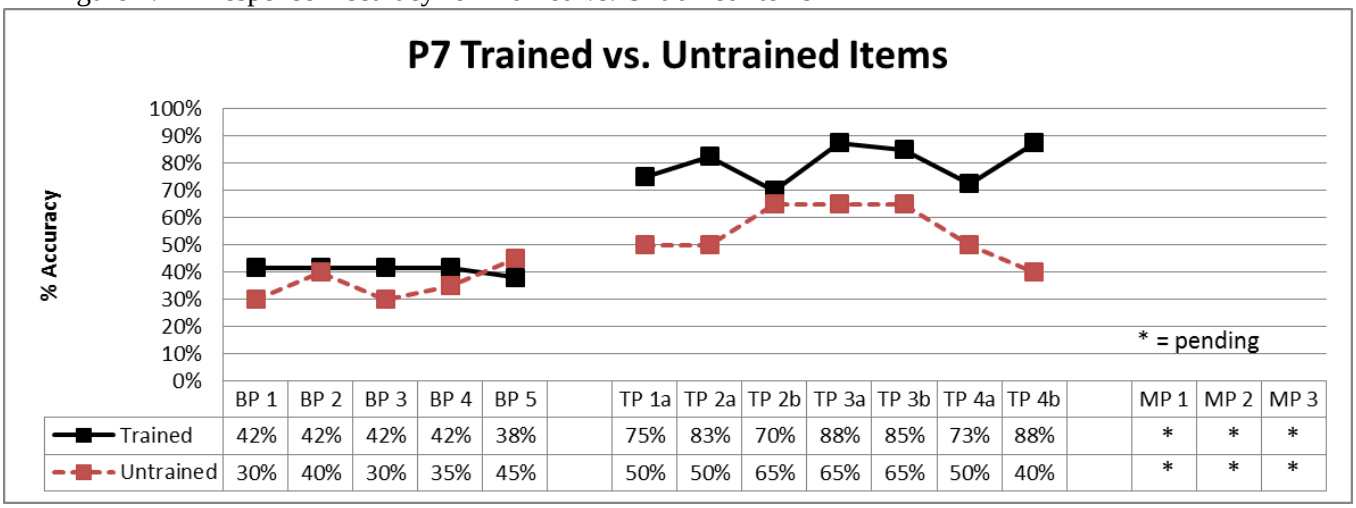
	BP 1	BP 2	BP 3	BP 4		TP 1a	TP 1b	TP 2b	TP 3a	TP 4a	TP 4b	TP 5a		MP 1	MP 2	MP 3
Trained	83%	75%	50%	42%		93%	95%	93%	98%	90%	95%	93%		90%	98%	*
Untrained	75%	65%	75%	75%		75%	75%	70%	80%	65%	80%	60%		60%	83%	*

Figure 6. P6 Response Accuracy for Trained vs. Untrained items



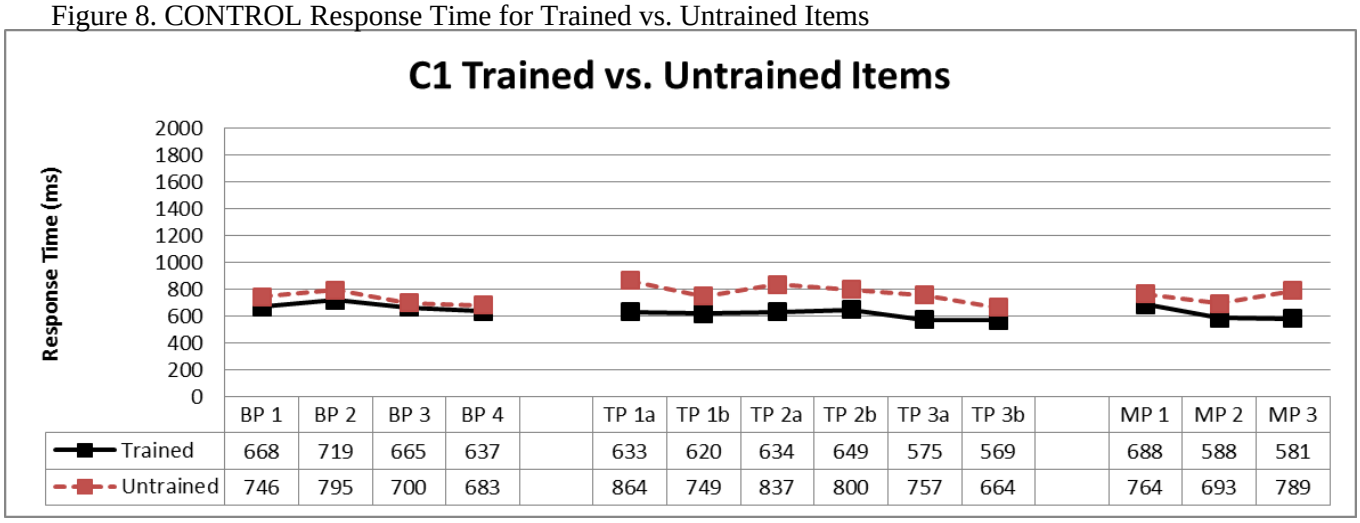
	BP 1	BP 2	BP 3	BP 4		TP 1a	TP 1b	TP 2a	TP 2b	TP 3a	TP 4a	TP 4b	TP 5a	TP 5b		MP 1	MP 2	MP 3
Trained	0%	0%	0%	0%		8%	3%	3%	5%	3%	5%	0%	10%	5%		5%	15%	20%
Untrained	0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	10%	15%		3%	6%	11%

Figure 7. P7 Response Accuracy for Trained vs. Untrained Items



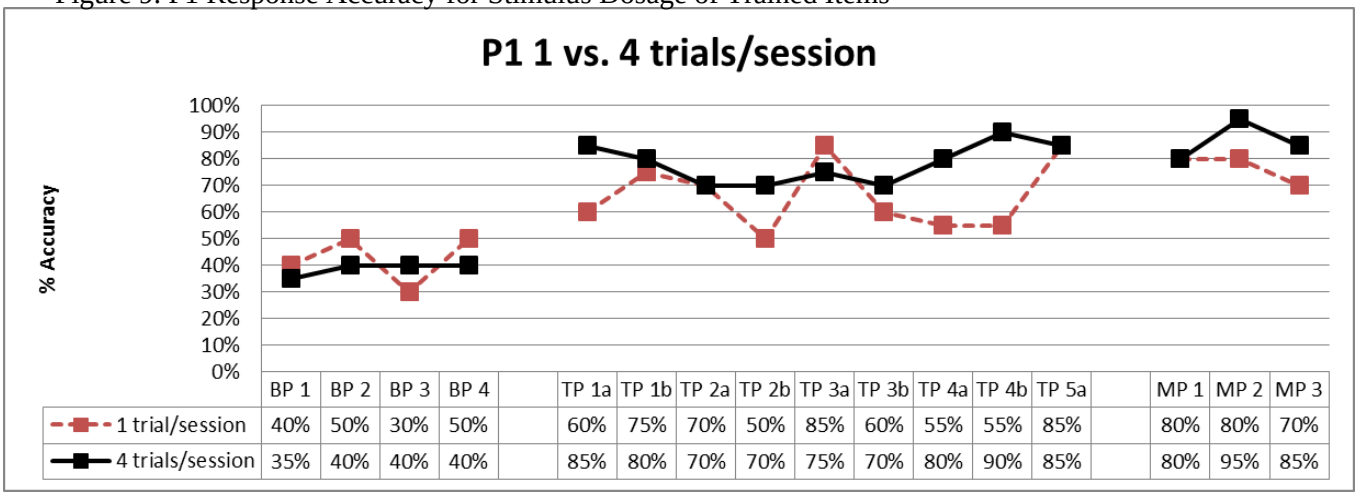
	BP 1	BP 2	BP 3	BP 4	BP 5		TP 1a	TP 2a	TP 2b	TP 3a	TP 3b	TP 4a	TP 4b		MP 1	MP 2	MP 3
Trained	42%	42%	42%	42%	38%		75%	83%	70%	88%	85%	73%	88%		*	*	*
Untrained	30%	40%	30%	35%	45%		50%	50%	65%	65%	65%	50%	40%		*	*	*

Figure 8. CONTROL Response Time for Trained vs. Untrained Items



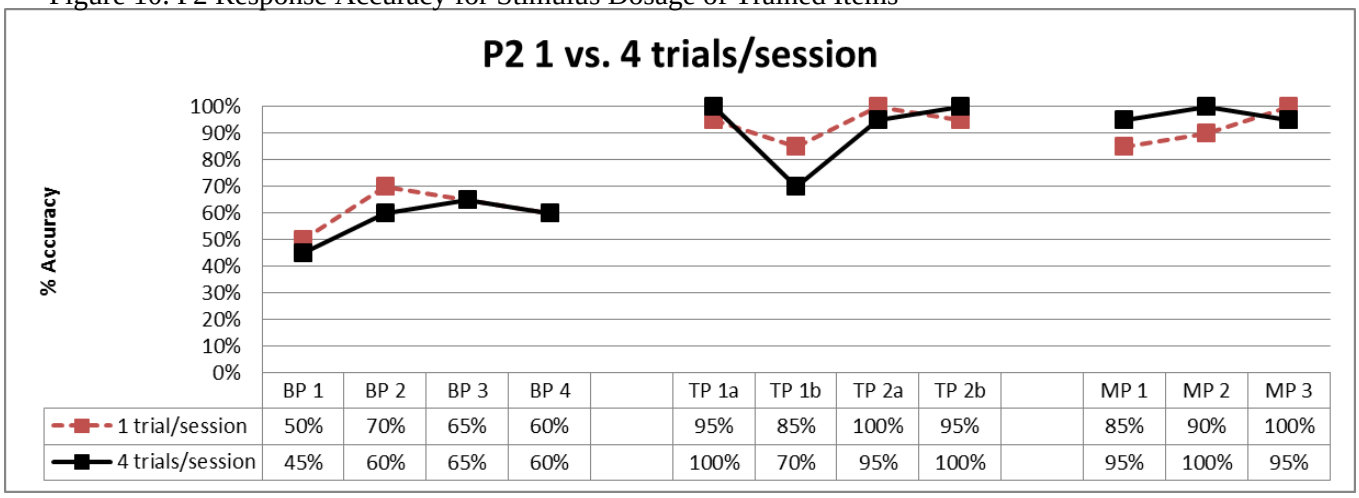
	BP 1	BP 2	BP 3	BP 4		TP 1a	TP 1b	TP 2a	TP 2b	TP 3a	TP 3b		MP 1	MP 2	MP 3
Trained	668	719	665	637		633	620	634	649	575	569		688	588	581
Untrained	746	795	700	683		864	749	837	800	757	664		764	693	789

Figure 9. P1 Response Accuracy for Stimulus Dosage of Trained Items



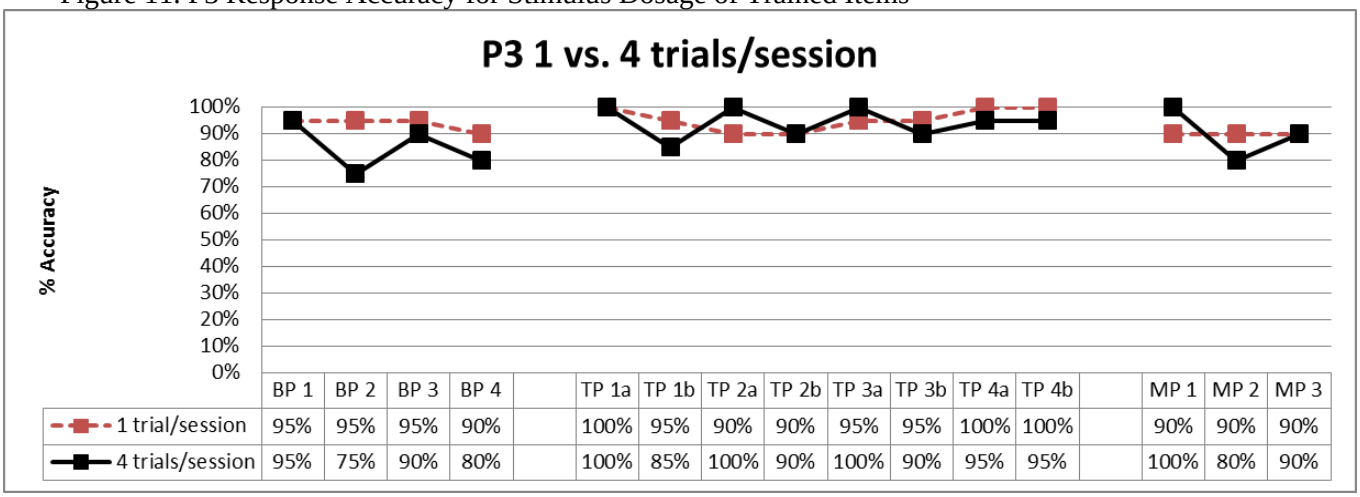
	BP 1	BP 2	BP 3	BP 4		TP 1a	TP 1b	TP 2a	TP 2b	TP 3a	TP 3b	TP 4a	TP 4b	TP 5a		MP 1	MP 2	MP 3
1 trial/session	40%	50%	30%	50%		60%	75%	70%	50%	85%	60%	55%	55%	85%		80%	80%	70%
4 trials/session	35%	40%	40%	40%		85%	80%	70%	70%	75%	70%	80%	90%	85%		80%	95%	85%

Figure 10. P2 Response Accuracy for Stimulus Dosage of Trained Items



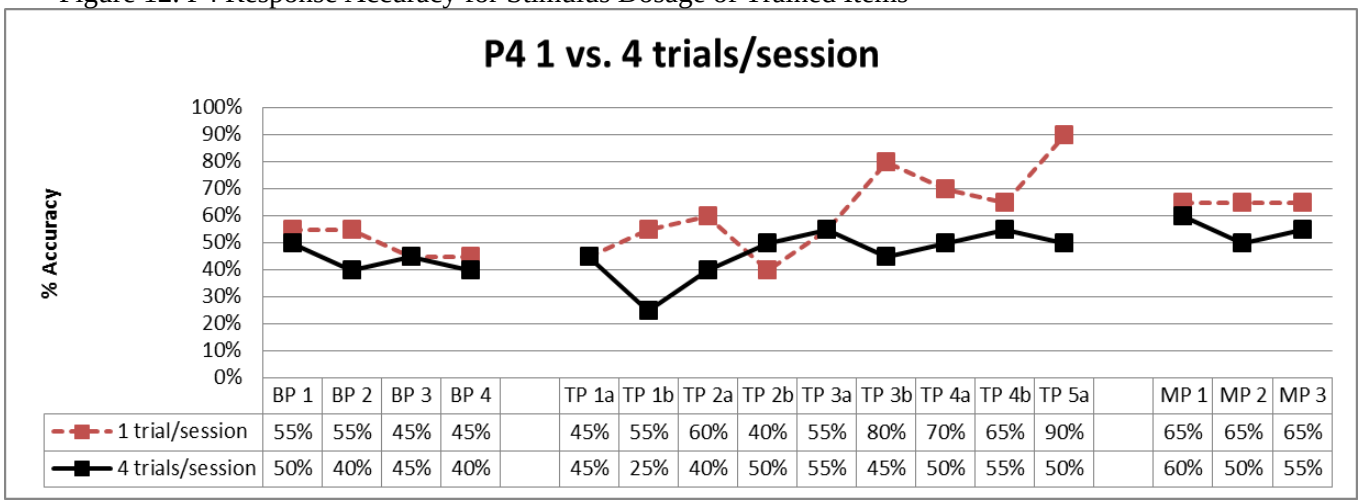
	BP 1	BP 2	BP 3	BP 4		TP 1a	TP 1b	TP 2a	TP 2b		MP 1	MP 2	MP 3
1 trial/session	50%	70%	65%	60%		95%	85%	100%	95%		85%	90%	100%
4 trials/session	45%	60%	65%	60%		100%	70%	95%	100%		95%	100%	95%

Figure 11. P3 Response Accuracy for Stimulus Dosage of Trained Items



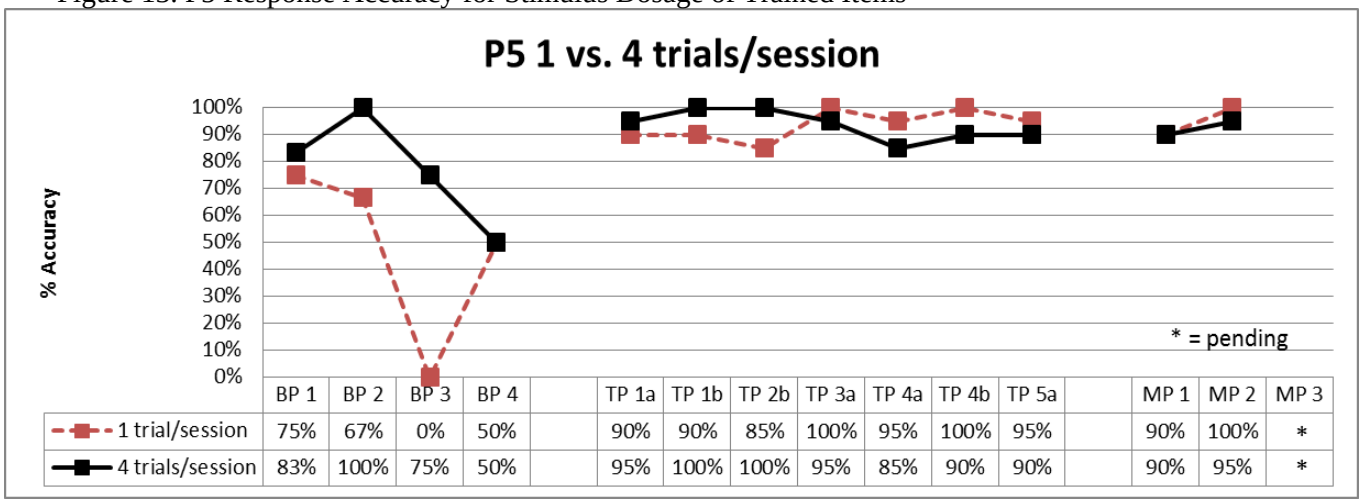
	BP 1	BP 2	BP 3	BP 4		TP 1a	TP 1b	TP 2a	TP 2b	TP 3a	TP 3b	TP 4a	TP 4b		MP 1	MP 2	MP 3
1 trial/session	95%	95%	95%	90%		100%	95%	90%	90%	95%	95%	100%	100%		90%	90%	90%
4 trials/session	95%	75%	90%	80%		100%	85%	100%	90%	100%	90%	95%	95%		100%	80%	90%

Figure 12. P4 Response Accuracy for Stimulus Dosage of Trained Items



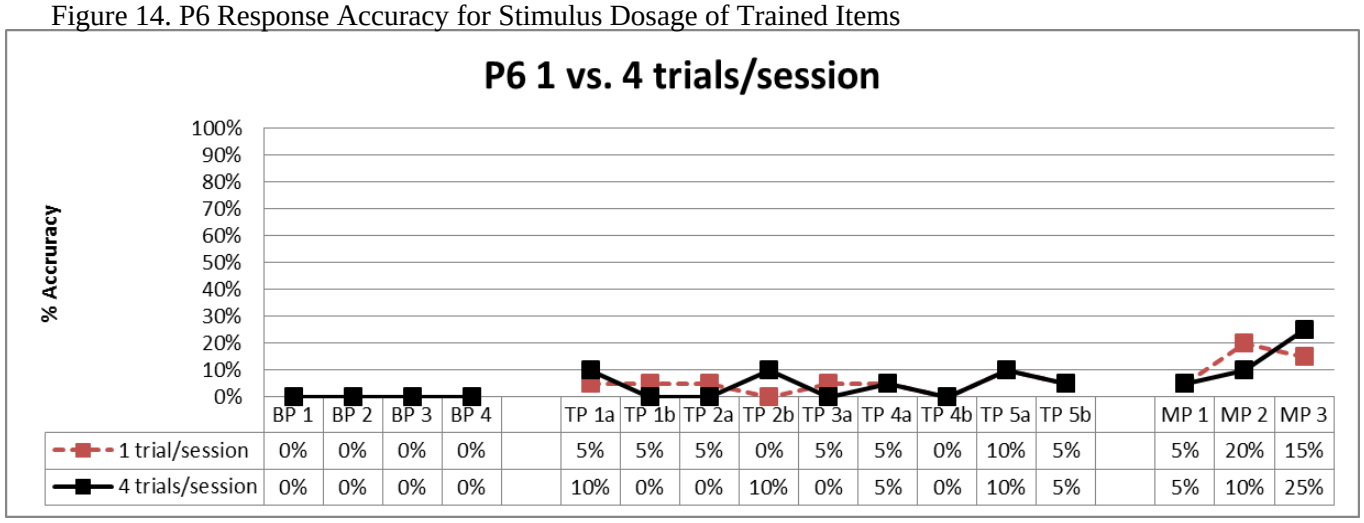
	BP 1	BP 2	BP 3	BP 4		TP 1a	TP 1b	TP 2a	TP 2b	TP 3a	TP 3b	TP 4a	TP 4b	TP 5a		MP 1	MP 2	MP 3
1 trial/session	55%	55%	45%	45%		45%	55%	60%	40%	55%	80%	70%	65%	90%		65%	65%	65%
4 trials/session	50%	40%	45%	40%		45%	25%	40%	50%	55%	45%	50%	55%	50%		60%	50%	55%

Figure 13. P5 Response Accuracy for Stimulus Dosage of Trained Items



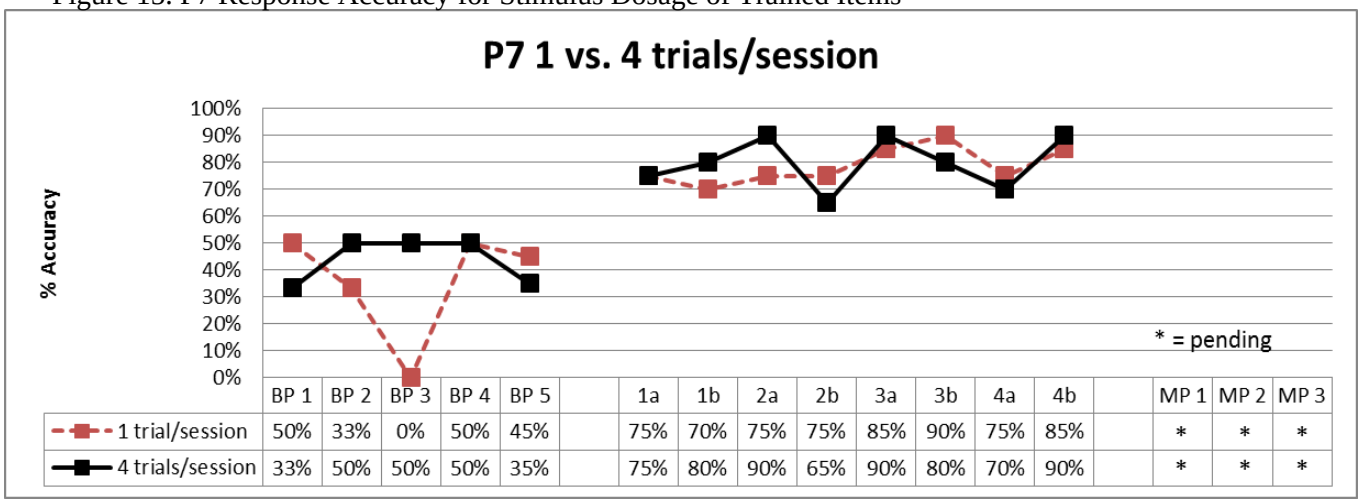
	BP 1	BP 2	BP 3	BP 4	TP 1a	TP 1b	TP 2b	TP 3a	TP 4a	TP 4b	TP 5a	MP 1	MP 2	MP 3
1 trial/session	75%	67%	0%	50%	90%	90%	85%	100%	95%	100%	95%	90%	100%	*
4 trials/session	83%	100%	75%	50%	95%	100%	100%	95%	85%	90%	90%	90%	95%	*

Figure 14. P6 Response Accuracy for Stimulus Dosage of Trained Items



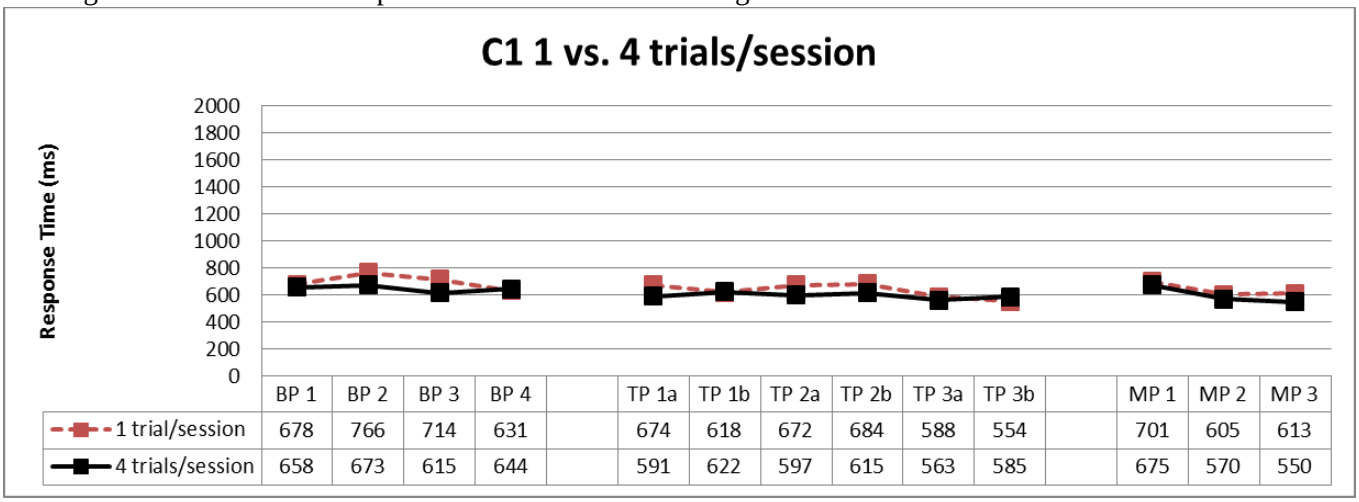
	BP 1	BP 2	BP 3	BP 4	TP 1a	TP 1b	TP 2a	TP 2b	TP 3a	TP 4a	TP 4b	TP 5a	TP 5b	MP 1	MP 2	MP 3
1 trial/session	0%	0%	0%	0%	5%	5%	5%	0%	5%	5%	0%	10%	5%	5%	20%	15%
4 trials/session	0%	0%	0%	0%	10%	0%	0%	10%	0%	5%	0%	10%	5%	5%	10%	25%

Figure 15. P7 Response Accuracy for Stimulus Dosage of Trained Items



	BP 1	BP 2	BP 3	BP 4	BP 5	1a	1b	2a	2b	3a	3b	4a	4b	MP 1	MP 2	MP 3
1 trial/session	50%	33%	0%	50%	45%	75%	70%	75%	75%	85%	90%	75%	85%	*	*	*
4 trials/session	33%	50%	50%	50%	35%	75%	80%	90%	65%	90%	80%	70%	90%	*	*	*

Figure 16. CONTROL Response Time for Stimulus Dosage of Trained Items



	BP 1	BP 2	BP 3	BP 4		TP 1a	TP 1b	TP 2a	TP 2b	TP 3a	TP 3b		MP 1	MP 2	MP 3
1 trial/session	678	766	714	631		674	618	672	684	588	554		701	605	613
4 trials/session	658	673	615	644		591	622	597	615	563	585		675	570	550