

The Effect of Falsification and Confirmation on Recategorization

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TABLE OF CONTENTS

<u>CHAPTER</u>	<u>PAGE</u>
I. INTRODUCTION	2
II. METHODS	10
A. Participants	10
B. Design	10
C. Materials	10
D. Procedure	10
1. Recategorization Task Phase 1: Misconception Learning	11
2. Recategorization Task Phase 2: Target Learning	12
3. Recategorization Task Phase 3: Assessment	14
III. RESULTS	15
A. Mastery Criterion	15
B. Misconception Learning	15
C. Target Learning	15
1. Verifying that the Participants Learned	16
2. Dichotomous Target Learning between Conditions	16
D. Rate of Learning	16
1. Percentage Correct	16
2. Percentage in Favor of Misconception Stimuli	18
3. Percentage in Favor of Target Stimuli	19
4. Block at which Target was Learned	19
E. Block 1 and 6 Breakdown by Trial	20
1. Complete Condition	20
2. Confirmation Condition	21
3. Falsification Condition	21
F. Performance at Assessment compared to Target Learning	22
G. Group Differences on Assessment	22
H. DISCUSSION	24
I. REFERENCES	28
J. IRB APPROVAL	42
K. CURRICULUM VITAE	45

LIST OF TABLES

<u>TABLE</u>	<u>PAGE</u>
I. OPPORTUNITIES TO CONFIRM OR DENY OXYGEN RESISTANCE BASED ON CONDITION IN EACH TARGET TRAINING BLOCK.....	31
II. FOLLOW-UP ANALYSES OF PERCENTAGE CORRECT BETWEEN CONDITIONS FOR PHASE 2 TARGET TRAINING	32
III. T-TESTS COMPARING PROPORTION OF RESPONSES CONSISTENT WITH THE MISCONCEPTION	33
IV. MEANS AND STANDARD DEVIATIONS FOR PROPORTION OF CORRECT RESPONSES FOR TARGET STIMULI	34
V. NUMBER OF PARTICIPANTS WHO LEARNED THE TARGET BY BLOCK.....	35

LIST OF FIGURES

<u>FIGURE</u>		<u>PAGE</u>
1.	Example bacteria with parts labeled	36
2.	Example of Bacteria with and without Parts Shown	37
3.	Response Types by Trial for the Complete Condition	38
4.	Response Types by Trial for the Confirmation Condition	39
5.	Response Types by Trial for the Falsification Condition	40
6.	Response by Stimuli Type for the Assessment Blocks.....	41

LIST OF ABBREVIATIONS

WCST	Wisconsin Card Sorting Task
ANOVA	Analysis of Variance
Tukey's HSD	Tukey's Honestly Significant Difference

SUMMARY

Researchers argue that dissatisfaction with a misconception is a prerequisite for adopting an alternative conception. An important cause of dissatisfaction is falsification. The present study investigated the importance of falsification and category induction opportunities when overriding a prior conception in favor of a new conception. Participants in the *confirmation* condition saw instances from which they could induce a novel method for categorization, but saw no instances in which they could directly falsify their prior conception. Participants in the *complete* condition saw both falsification and novel-categorization-induction opportunities. Participants in the *falsification* condition could falsify the misconception, but received ambiguous target induction opportunities. All three conditions were successful in learning the novel categorization method. However, the confirmation condition adopted the novel categorization method in fewer training blocks than both the complete and falsification conditions. The results suggest that, contrary to widespread belief in the conceptual change literature, removing direct falsification opportunities, but providing induction opportunities is an effective method for prompting conceptual change and can result in faster change. Implications for future research and limitations are discussed.

I. INTRODUCTION

Researchers argue that dissatisfaction is a prerequisite for conceptual change, because dissatisfaction with a misconception can lead to the adoption of a more correct conception (Chi, 2005; Chi, 2008; Chi & Brem, 2009; Chi & Ohlsson, 2005; Elio & Pelletier, 1997; Gopnik & Wellman, 2012; Ohlsson, 2011; Ozdemir & Clark, 2007; Slotta & Chi, 2006; Strike & Posner, 1982, 1992). A common method for producing dissatisfaction with a misconception is to use corrective feedback, which provides the learner with information that disconfirms the misconception and confirms the correct conception. More specifically, corrective feedback can be divided into two types. One type is *confirmatory*, in which a new conception is supported. The other type is *falsifying*, in which an old conception is rejected. Confirmatory feedback allows the learner to induce a new conception, or increase the degree of certitude regarding his or her currently held conception (Butler & Wine, 1995). Falsifying feedback allows the learner to reject a prior conception (Ohlsson, 2011).

For example, Strike and Posner's (1982) model claims that there must be dissatisfaction with a current conception. Moreover, dissatisfaction must surpass the threshold at which accommodation supersedes assimilation. They argue that the threshold is surpassed by the accretion of contradictory bits of information that accumulate to a level at which the discrepancy cannot be attributed to anomalies or be ignored.

Similarly, the Theory-Theory posits that the revision process takes place when dissatisfaction with the current conception reaches an individual's threshold for conceptual change (Gopnik & Wellman, 2012). That is, counter evidence fosters dissatisfaction that, in turn,

promotes theory change. Without counter evidence and subsequent dissatisfaction conceptual change would not occur.

As a final example, Categorical Shift theory describes conceptual change as a process that requires one to abandon or reject prior misconceptions via the recognition of differences between general categories called ontological categories (Chi, 2005; Chi & Brem, 2009). Specifically, when confronted with information that does not coincide with the existing knowledge base dissatisfaction with the current conception can occur. Dissatisfaction leads to a search for an alternative knowledge structure capable of accommodating the new information. In general, these theories are proponents of the need for dissatisfaction to foster change. Dissatisfaction is supposed to motivate the learner to seek and adopt a new conception.

Dissatisfaction in the context of conceptual change can be described as a dysfunction of a conception that becomes noticeable when taking into account its relationship to the environment and other conceptions. For example, the process of falsification provides evidence that a conception is dysfunctional, and as a result leads to dissatisfaction. Therefore, falsification can be considered one method that can be used to create dissatisfaction.

Is it possible for there to be other processes that lead to conceptual change that do not require falsification? In contrast to the theories mentioned above, the Resubsumption Theory claims that conceptual change can occur even in the absence of falsification of a person's current conception. This is possible when the learner possesses two alternative theories that apply to the same case or phenomenon. Change from one theory to the other occurs through competitive evaluation on the basis of *cognitive utility* rather than truth or falsity (Ohlsson, 2009). Competitive evaluation triggers a change by revealing that the alternative theory is more

applicable in a given instance, which is not the same as directly falsifying a prior conception in favor of another.

Conceptual change is a difficult process to study empirically because of the variability in prior knowledge surrounding a given conception, emotional sensitivity for the conception, and other logistical and ethical considerations. For example, a seriously inaccurate representation of a conception may result in greater challenges to conceptual change compared to learners with a less serious misrepresentation. Additionally, some topics can be emotionally sensitive to certain groups, such as descriptions of history from either a scientific or a theological perspective. In addition, logistically, it is difficult to follow someone around that may hold a misconception and see how he or she reacts to novel contradictory information in a naturalistic setting.

Nonetheless, conceptual change can be studied in a way that reduces the impact of prior knowledge, namely, by using novel stimuli. In the *recategorization paradigm* participants learn how to categorize a novel set of stimuli, and then have to recognize when a switch in the rule for categorizing occurs. Images that can be sorted in a variety of ways are used for such a task. This type of study can be conducted in a single experimental session, and is less likely to present prior knowledge confounds due to the novelty of the stimuli.

A classic example of recategorization is the Wisconsin Card Sorting Task (WCST), in which participants learn to sort a set of cards based on one of three features (color, shape, or number of objects displayed; Grant & Berg, 1948). The learner categorizes based on the experimenter's feedback. That is, the experimenter lets the learner know if he or she is correct in the sorting process. Moreover, when the learner correctly sorts the cards 10 times the rule is then

changed unbeknownst to the participant. It is up to the learner to realize that the rule has changed and to discover the new sorting rule.

For the WCST, receiving feedback that can be used to falsify a hypothesis gives the learner evidence that his or her categorization method is incorrect. This should result in dissatisfaction with the sorting method and the formulation of novel hypotheses in order to find the correct sorting practice. Eventually, the learner may test other methods of sorting and discover the new rule when confirmatory feedback aligns with the correct hypothesis. The learner's knowledge of the correct rule is considered a product of confirmatory feedback. In short, recategorization occurs in the WCST when falsifying feedback promotes dissatisfaction and confirmatory feedback promotes acceptance of a novel sorting method.

One version of recategorization that uses conceptually similar procedures as the WCST presents stimuli that mimic a science-learning environment (Cosejo, Oesterreich, & Ohlsson, 2009; Ramsburg & Ohlsson, 2013). Fictitious bacteria images are used as stimuli. The learner's goal is to determine the factors that control the bacteria's resistance to environmental conditions. For example, a misconception feature of the bacterium is learned over the course of many trials. After learning the misconception the categorization value is changed unbeknownst to the learner. Learner then uses the feedback to find the new categorization method. This type of a paradigm allows for single session exploration into recategorization that is not restricted by limitations in prior knowledge, or ethical and logistical considerations. Moreover, data can be collected at each decision point allowing for a fine grained breakdown of the process of recategorization.

The present thesis investigates whether falsifying feedback is necessary for categorical change in the recategorization paradigm. It is an investigation into the ability to use feedback

about stimuli that are manipulated in a way that affects a learner's ability to confirm and falsify hypotheses in the recategorization paradigm.

There are three competing hypotheses. The *standard* hypothesis derives from the theories of conceptual change reviewed previously that posit the need for falsification for conceptual change to occur. This hypothesis predicts that those participants who see stimuli that can be used to both falsify a prior conception and induce and confirm a new conception (*the complete condition*) should outperform those that can falsify their prior conception, but have no opportunities to induce the new conception (*the falsify condition*), which in turn will outperform those that can induce and confirm a new conception, but have no opportunity to falsify the old conception (*the confirmation condition*).

The first alternative hypothesis, the *falsification neutral* hypothesis, claims that falsification is neither helpful nor harmful, but neutral when attempting to facilitate categorical change, but that category induction opportunities are important. This hypothesis predicts that the complete and confirmation conditions will perform equally well, and that both will outperform the falsification condition.

The second alternative hypothesis, the *falsification harmful* hypothesis, is novel. This hypothesis states that falsification is not only unhelpful, but can be harmful when attempting to facilitate categorical change. This hypothesis predicts that confirmation condition will outperform the complete condition, and that the complete will outperform the falsification condition. This is because the need to reduce the strength of activation for the misconception and increase the strength of activation for the target will take more time than only increasing the strength of activation for the target.

These hypotheses were implemented in the experimental design in the following ways. All participants were first exposed to stimuli for which feedback could be used to confirm and falsify hypotheses when they learned the initial conception (i.e., the conception that eventually needed to be overridden). This *initial category learning phase* consisted of 80 learning trials.

After learning an initial conception (i.e., the misconception) the participants were exposed to one of three different conditions that varied in the information provided by the stimuli with the goal of learning the new conception (i.e., the target conception). This *target learning phase* also consisted of 80 learning trials.

The complete condition provided both target induction and misconception falsification opportunities. The complete condition received a balance of stimuli that could be used for category induction and falsification. This would allow for the interaction of falsification and category induction opportunities to be examined holistically. The confirmation condition provided target induction opportunities, but no misconception falsification opportunities.

The confirmation condition contained stimuli that could be used to gain support for the new categorization method, but not to falsify the old method for categorizing. This condition tested the independent influence of seeing stimuli that can be used to confirm a new categorization method without the motivation of falsification of the prior conception. The falsification condition provided ambiguous target induction opportunities and misconception falsification opportunities. The falsification condition received stimuli that can be used to falsify the misconception, and stimuli that might appear inconsistent because they contained both the misconception and the target, causing the interpretation of the feedback to be ambiguous. This condition allowed for an examination of the effectiveness of falsification with ambiguous support for the target, which is

perhaps the best real world example of what learners might be confronted with in everyday life. These three conditions allowed examination of the differential influences of having falsification versus having category induction opportunities versus having both and thus to determine which of the three hypotheses provides the best account of the data.

The hypotheses were investigated via measures of overall success and rate of learning. The first measure, overall success, is defined as the proportion participants who correctly categorize at least 14 of 16 stimuli on any given target training block. The results were examined between groups and compared to chance performance. The second measure, rate of learning, is defined as the percentage correct for each target training block. The results were examined between groups.

For the first measure, overall success, the standard hypothesis predicts that the complete condition should perform better than the other two conditions. This is expected because the dissatisfaction that comes with falsification opportunities will prompt change and the target induction opportunities will guide change. The falsification neutral hypothesis predicts that both the complete and confirmation conditions should perform better than the falsification condition. This was expected because the ability to confirm the target based on the stimuli and feedback would allow learners to adopt the target category (for both confirmatory and complete conditions), but the absence of direct category induction without interference from the misconception feature would hinder the learner's ability to adopt the target category for the falsification condition. Moreover, no differences between the confirmation and complete conditions would demonstrate that falsification is not necessary for recategorization to occur. The falsification harmful hypothesis predicts that the confirmation condition should perform better than the other two conditions because falsification opportunities require the learner to

reduce the strength of activation for the misconception and increase the strength of activation for the target, which is more effortful than only increasing the strength of activation for the target.

For the second measure, speed of categorization, the standard hypothesis predicts that the complete condition will learn the fastest, followed by the falsification condition, and, lastly, the confirmatory condition. This outcome would imply that having both category induction opportunities and falsification could result in the fastest learning, but that category induction opportunities without falsification would not result in categorical change. That is, falsification is necessary for categorical change. The falsification neutral hypothesis would find that no difference exists between the complete and confirmation conditions, but the falsification condition would be slower in recategorizing. This would suggest that the presence or absence of falsification has no effect on categorical change so long as stimuli that can be used to confirm category membership are available. The falsification harmful hypothesis would find that speed of learning is fastest for the confirmation condition followed by the complete condition, and lastly the falsification condition. This type of outcome would demonstrate that falsification is not only unnecessary for categorical change, but that it can also hinder categorical change as evidenced by the complete condition being slower to recategorize compared to the confirmatory condition.

II. METHODS

A. Participants

A One hundred fifty introductory psychology students at University of Illinois at Chicago participated in the study for course credit. Three were removed from the study due to data capturing errors.

B. Design

The study was a between-participants design. The participants were randomly assigned to one of three conditions (Complete, Falsification, and Confirmation).

C. Material

The materials consisted of 132 images of fictional bacteria (see Figure 1). The bacteria had six parts that had different binary attributes resulting in 64 variants: Nuclei (grey or black), Headbulbs (three or none), Ribosomes (bent or straight), Tail Cilia (present or absent), Cell Membrane (singular or double), and Cytoplasm (white or grey). Additionally, some images did not display all parts. For example, some images did not show the nuclei, tail, or the ribosomes (see Figure 2). When a part was not displayed, its attribute value was unknown. The images were presented one at a time on a computer screen via E-Prime software (www.pstnet.com/products/E-Prime/default/).

D. Procedure

Participants entered the laboratory and sat at separate computer stations separated by dividers. Each participant first participated in a training session, which consisted of a series of PowerPoint slides outlining how one can sort a variety of objects into different categories. The training

session ended with participants categorizing simple stick figures based on their features. When participants finished with the initial training, they began the more challenging bacteria categorization task.

Participants read the instructions for the task on the computer screen and asked questions if needed. Participants were given a script stating that alien bacteria were recently discovered on a distant planet and that scientists needed to determine whether there are oxygen resistant variants of the bacteria. Participants were asked to rate how important each feature might be in determining oxygen resistance on a 7-point Likert scale from 1 (Not at all) to 7 (Extremely). After rating the features, participants read a prompt that described the importance of determining which bacteria are oxygen resistant. Thereafter, participants read a prompt suggesting that parts within the cell body may be influential in determining oxygen resistance. Both the misconception and target feature are within the cell body. The purpose of the hint is to reduce attrition due to failures of some participants to learn the initial conception.

1. Recategorization Task Phase 1: Misconception Learning. In each trial, the participant was to determine whether the displayed bacterium was oxygen resistant. Participants indicated their responses via the keyboard. The following responses were acceptable: y= yes, n=no, d= don't know. Participants then received immediate feedback from the computer, including whether the bacterium was or was not oxygen resistant, the participants' own response, and whether the participant was correct or incorrect in his or her classification. In addition, an image of the bacterium they classified was also displayed with the feedback. Participants were instructed to make as few errors as possible.

Participants first learned to categorize whether an alien bacteria was oxygen resistant based on feedback that supported the misconception feature (black nuclei) over the course of five training blocks of 16 trials each. Each training block was balanced to include in randomized order six images that contained the misconception, six images that contained the target, two images that contained neither, and two images that contained both the misconception and the target. The materials, instructions, and procedure used in this phase were the same for all three conditions.

2. Recategorization Task Phase 2: Target Learning. After five training blocks, unbeknownst to the participants the feature that determined oxygen resistance was changed from *black nuclei* to *bent ribosomes* (the target feature). There was no break in the procedure. Participants had five target training blocks of 16 randomized trials to learn that bent ribosomes determined oxygen resistance. The target training differed for the three different experimental conditions (see Table I).

Condition 1: Complete Stimuli. This condition presented stimuli that could be used to both falsify the misconception and induce or confirm the target. Each training block contained 16 images, and their order was randomized. There were eight images that provided an opportunity to falsify the misconception. These images contained the misconception feature but not the target feature (i.e., *black nuclei* and *straight ribosomes*). These images afforded the opportunity to reject the misconception, but did not support target induction. There were also eight images that provided an opportunity to induce the target. These images contained the target feature, but the misconception feature was unknown (i.e., *bent ribosomes* and *nuclei unknown*). The images afforded opportunities for target induction, but not misconception rejection. For example, in Phase 1, the participant learned that black nuclei are responsible for oxygen resistance. In Phase

2, the participant was confronted with an image containing black nuclei with feedback stating that the bacterium is not oxygen resistant. This feedback should allow the learner to negate the prior conception.

Condition 2: Confirmatory Stimuli. This condition displayed no stimuli that could be used to directly falsify the misconception. Each training block was balanced and the order of the stimuli was randomized. As in the confirmatory condition, there were eight images that provided opportunities to induce or confirm the target. These images contained the target feature, but the misconception was unknown (i.e., *bent ribosomes* and *nuclei unknown*). These images afforded the opportunity for target induction, but not misconception rejection. There were eight images that did not enable participants to infer the misconception or the target, but that could be used to reject alternatives. These images did not contain either the target or the misconception (i.e., *grey nuclei* and *straight ribosomes*). These images afforded no opportunity to reject the misconception and did not support target induction.

Condition 3: Falsification Stimuli. This condition displayed no stimuli that could be used to directly induce or confirm the target conception. Each training block was balanced and the order of the stimuli was randomized. As in the complete condition, there were eight images that provided opportunities to falsify the misconception. These images contained the misconception feature but the target feature was not present (i.e., *black nuclei* and *straight ribosomes*). The images afforded the opportunity to reject the misconception, but did not support target induction. There were eight images that contained both the target and the misconception features (i.e., *black nuclei* and *bent ribosomes*). These images afforded opportunities for target and misconception induction.

3. *Recategorization Task Phase 3: Assessment.* After the 5 blocks of target training, the participants were asked to continue classifying bacteria without any feedback. This lasted for two blocks of 16 trials each. Each assessment block was balanced to include in randomized order three images that had the target feature but not the misconception feature, three images that contained the misconception feature but not the target feature, three images in which the misconception was unknown and the target was present, three images in which the misconception was unknown and the target was not present, two images that did not contain the misconception or the target, and two images that contained both the misconception feature and the target feature.

Additionally, after completing all trials, participants were asked how motivated they were to perform the task well and to rate the importance of different features in determining oxygen resistance on the same 7-point likert scale (1= Not at All to 7= Extremely) that was used in the initial ratings. Afterwards, participants typed in a response to the question what they thought determined oxygen resistance. They were then asked to type in a response to the question whether oxygen resistance was always determined the same way. Finally, the participants answered demographic questions, and they were thanked for their participation and debriefed.

III. RESULTS

A. Mastery Criterion

A strict mastery criterion for misconception learning was used because the ability to recategorize requires the learner to have a method of categorizing before it can be changed. That is, participants would need to first learn the misconception in order for the recategorization process to occur. The *mastery criterion* was to correctly classify 14 of 16 alien bacteria in any one block in Phase 1 of training. Successful learning of the target was defined as performance of 14 out of 16 or greater on any of the blocks 6 through 10 (i.e., phase 2). For example, if a participant scored 15 out of 16 on block 7 he or she was coded as having learned the target category. Thirty participants in the complete condition, 24 participants in the confirmatory condition, and 31 participants in the falsification condition met the mastery criterion for inclusion in analyses examining target learning performance.

B. Misconception Learning

An investigation of whether participants differed in misconception learning as a function of condition was examined in order to test that whether the groups were equivalent. Thirty out of 50 participants in the complete condition, 24 out of 50 participants in the confirmatory condition, and 31 out of 47 participants in the falsification condition successfully learned the misconception. A Chi-squared test-of-independence was used in order to dichotomously compare number of participants in each group that successfully learned the misconception category to each other. The results revealed that the groups did not differ in misconception learning, $\chi^2(2, 150) = 3.24, p = .198$. Specifically, there was no evidence for nonequivalent groups.

C. Target Learning

1. Verifying that the Participants Learned. The first analysis examined whether participants learned the target. This was done by comparing them to chance performance. All participants that learned the misconception were successful in learning the target for the complete condition ($n = 30$) and for the confirmation condition ($n = 24$). However, for the falsification condition, 3 out of 31 failed to learn the target. Performance was compared to a chance performance of 50% using a Chi-squared goodness of fit analysis. The result showed that participants in the falsification condition performed better than chance, $\chi^2(31) = 20.16, p < .001$. In short, there was evidence for target learning in all three conditions.

2. Dichotomous Target Learning between Conditions. An investigation of whether participants differed in target learning as a function of condition was examined in order to test the three competing hypotheses. The standard hypothesis predicted that the complete condition should outperform the other two conditions. The falsification neutral condition predicted that the falsification condition underperforms compared to the other two conditions. The falsification harmful hypothesis predicted that the confirmation condition should outperform the other two conditions. A Chi-squared test-of-independence was used in order to dichotomously compare number of participants in each group that successfully learned the target category to each other. The results revealed that the groups did not differ in target learning, although the trend in the data suggests that the falsification condition, where 9.67% failed to learn the target, may have more difficulty adopting the target, $\chi^2(2, 85) = 5.42, p = .067$.

D. Rate of learning

1. Percentage Correct. The following analyses were conducted in order to investigate how quickly learners could adopt the target conception between groups. Specifically, rate of

learning measured by percentage correct per block was examined. The standard hypothesis predicted that the complete condition should learn faster than the other two conditions. The falsification neutral condition predicted that the falsification condition should learn slower compared to the other two conditions. The falsification harmful hypothesis predicted that the confirmation condition should learn faster than the other two conditions.

These hypotheses were tested via a repeated-measures analysis of variance (ANOVA), where each group was compared over the course of the five target training blocks using percentage correct per block as the repeating measure. The repeated measures ANOVA found a main effect for blocks showing that participants across blocks, $F(4, 79) = 86.329, p < .001$, $\eta^2_{\text{partial}} = .513$. In addition, a main effect for condition suggests that the groups differed in rate of learning, $F(2, 82) = 16.68, p < .01$, $\eta^2_{\text{partial}} = .289$. The main effects were qualified by an interaction between blocks and condition, $F(2, 82) = 19.63, p < .001$, $\eta^2_{\text{partial}} = .324^1$. After an examination of the profile plot for the data, pairwise comparisons were conducted (see Table II). The results from Table 2 suggest that the complete and confirmation conditions differ from each other on performance at block 6, such that the confirmation condition performed better than the complete condition (i.e., support for the falsification harmful hypothesis). There were no differences between the two conditions on blocks 7-10. In contrast, the falsification condition underperformed compared to both the complete and the confirmation conditions on blocks 6 through 9. The effect sizes were generally largest at block 6 with decreasing effect size with later training blocks.

¹ The same results were found when removing the three participants in the falsification condition that did not learn the target.

The results suggest that the confirmatory condition may result in faster learning of a new conception than either complete or falsification conditions. Moreover, the results suggest that the falsification condition, one in which conflicting information is presented, results in the slowest target learning.

2. Percentage in Favor of Misconception Stimuli. The purpose of this analysis was to investigate whether the falsification and complete conditions differed in speed of rejecting the misconception. An analysis was conducted that examined only those responses to stimuli in which the misconception feature was present, but the target feature was not. This occurred for 8 trials in each of blocks 6 through 10. It was hypothesized that the falsification condition would be slower in rejecting the misconception due to the presence of stimuli that contain both the misconception and the target (the other 8 stimuli seen per block for the falsification condition). That is, having all stimuli containing the misconception, where half of the stimuli are oxygen resistant (where the target is also present) and the other half are not (where the target is not present) would cause participants to become uncertain. Participants had already received a strong support for the misconception in the misconception training phase and were subsequently receiving further support on half of the trials during the target training phase. This should ultimately lead to more perseverative errors. The latter are errors that occur when a participant categorizes the misconception bacteria as oxygen resistant after receiving feedback that falsifies the misconception.

A repeated-measure ANOVA for percentage of items rated as being oxygen resistant that contain the misconception but not the target was conducted for blocks 6 through 10. A main effect for blocks showed that participants made fewer responses in favor of the misconception with training, $F(4, 56) = 103.94, p < .001, \eta^2_{\text{partial}} = .638$, and there was a main effect for

condition suggesting that the groups differed in speed of rejecting the misconception, $F(1, 59) = 24.57, p < .001, \eta^2_{\text{partial}} = .294$. The main effects were qualified by an interaction between blocks and condition, $F(4, 56) = 12.61, p < .001, \eta^2_{\text{partial}} = .176$. Follow-up analyses revealed that the complete condition rejected the misconception at a higher rate than the falsification condition for blocks 6 through 9 (see Table III).

3. Percentage in Favor of Target Stimuli. The purpose of this analysis was to investigate whether the confirmation and complete conditions differed in speed of accepting the target conception. An analysis was conducted that examined only those responses to stimuli where the target was present, but the misconception was unknown. It was hypothesized that the confirmatory condition would support the target category at a faster rate than the complete condition. This result was expected because the complete condition needed to reduce the strength of activation for the misconception, whereas the confirmatory condition did not.

A repeated measures ANOVA found a main effect for blocks showing that participants increased “yes” responding in favor of the target as training progressed, $F(4, 49) = 53.02, p < .001, \eta^2_{\text{partial}} = .505$. There was no main effect for condition suggesting that the groups did not differ in this respect, $F < 1, p = .785, \eta^2_{\text{partial}} = .001$. No interaction was found between blocks and condition, $F(4, 49) = 1.54, p = .193, \eta^2_{\text{partial}} = .029$. See Table IV for means and standard deviations. In short, no evidence was found to support the hypothesis that one group adopted the target category faster than the other.

4. Block at which Target was Learned. This analysis was conducted in order to investigate rate of learning in the context of block at which target learning occurred. A one-way ANOVA was conducted that examined the differences between the groups for block when target

learning was mastered (i.e., correctly classifying at least 14 out of 16 in a given block). That is, learning in block 6 was coded as 1; learning in block 7 was coded as 2, and so on. The three participants who failed to learn the target in the falsification condition were removed from this analysis. The results revealed that the conditions differed in which block target learning was mastered, $F(2, 79) = 13.55, p = .193$ (see Table V). Post-hoc Tukey's HSD tests showed that the confirmation condition ($M = 1.38, SD = .77$) learned faster than the complete condition ($M = 1.93, SD = .58$), $p = .042$, and the falsification condition ($M = 2.57, SD = .1.07$), $p < .001$. The complete condition learned faster than the falsification condition, $p = .012$.

E. Block 1 and 6 Breakdown by Trial

A trial by trial breakdown of the first block (i.e., Block 1) and the first block after the switch (i.e., Block 6) offers a closer view of the initial learning and conceptual change process phases. Stimulus type was randomized within each block. The randomization process means that a one to one relationship cannot be used for analysis of response types by trials since not all participants receive the same stimulus type on any given trial. However, analyses for response types by trial based on averages where approximately 50% of participants respond for a given stimulus type on a given trial in a given condition was used for block 6. Block 1 involves response types for four different stimuli types (see *Recategorization Task Phase 1* in the Method section), however, only stimuli types in which misconception or target consistency could be determined are shown.

1. Complete Condition. For the complete condition block 6, half of all participant responses were in relation to stimuli that met the condition of having the misconception present and the target feature not present (i.e., dark nuclei and straight ribosomes). A “yes” response for those stimuli would indicate misconception consistent responding. The other half of the

responses were in relation to stimuli that met the condition of having the target feature, but the misconception was unknown. A “yes” response for stimuli of the aforementioned type (i.e., nuclei type unknown with bent ribosomes) would indicate a target consistent response. Figure 3 shows that for the complete condition change is happening early. Most of the learning occurs in the first seven or eight trials of Block 6.

2. *Confirmatory Condition.* For the confirmation condition block 6, half of all participant responses were in relation to stimuli that met the condition of not having the misconception or the target feature not present (i.e., light nuclei and straight ribosomes). A “no” response for those stimuli would indicate an indeterminate correct rejection. The other half of the responses were in relation to stimuli that met the condition of having the target feature, but the misconception was unknown. A “yes” response for stimuli of this type (i.e., nuclei type unknown with bent ribosomes) would indicate a target consistent response. Figure 4 shows that for the confirmatory condition change is happening early. Most of the learning occurs in the first five trials of Block 6.

3. *Falsification Condition.* For the falsification condition block 6, half of all participant responses were in relation to stimuli that met the condition of having the misconception present and the target feature not present (i.e., *dark nuclei* and *straight ribosomes*). A “yes” response for those stimuli would indicate misconception consistent responding. The other half of the responses were in relation to stimuli that met the condition of having the target and the misconception present. A “yes” response for stimuli of this type (i.e., *dark nuclei* with *bent ribosomes*) would indicate indeterminate correct responding. Figure 5 shows the change happening slowly and it continues across all 16 trials of Block 6.

F. Performance at Assessment Compared to Target Learning

A comparison of performance from Phase 2 to Phase 3 was conducted in order to show that the absence of feedback is harmful regardless of condition. Half of the stimulus items for the assessment were novel attribute combinations that prevent item based responding. That is, these new images control for the possibility that participants were simply memorizing answers for images that they had previously seen (i.e., not using a categorization rule). For the assessment, it was expected that there would be a decrease in performance regardless of group because all participants would rely on instance-based learning to some degree. In addition, prior experience with the re-categorization paradigm has always shown lower performance on assessed blocks than on the last target learning block. Percentage correct for assessment blocks was compared to percentage correct on block 10 of target learning via three separate t-tests, one for each condition. The results revealed that the complete condition underperformed on the assessment block in comparison to performance on block 10 ($M = 66.46$, $SD = 20.10$), $t(29) = 109.29$, $p < .001$ as did the confirmation condition ($M = 47.27$, $SD = 8.90$), $t(23) = 87.24$, $p < .001$, and the falsification condition ($M = 69.05$, $SD = 22.00$), $t(30) = 36.47$, $p < .001$.

G. Group Differences on Assessment

A comparison of group differences on assessment offered an opportunity to investigate how learners faced with different stimuli would perform when confronted with different stimulus types. Figure 6 shows participants responses based on stimuli type for the assessment block. The standard hypothesis predicted that the complete condition should respond more accurately than the other two conditions. The falsification neutral condition predicted that the falsification condition should be the least accurate compared to the other two conditions. The falsification

harmful hypothesis predicted that the confirmation condition should be more accurate than the other two conditions.

The hypotheses were tested via separate t-tests with each group's percentage correct on assessment being compared. The results revealed that the complete and falsify conditions did not differ from each other, $t(59) = .48, p = .633$, but that the complete condition performed better than the confirmation condition, $t(52) = 4.34, p < .001$, as did the falsification condition, $t(53) = 4.56, p < .001$. The results partially supported the standard hypothesis.

IV. DISCUSSION

The present study examined whether assigning participants randomly to one of three types of stimuli configurations would influence recategorical change. Three competing hypotheses were tested (i.e., the standard, falsification neutral, and falsification harmful hypotheses). An examination of the results for the complete and confirmation conditions follows. Both the complete and confirmation conditions were successful in learning the target. However, the confirmation condition performed better on Block 6 compared to the complete condition. This suggests that participants in the complete condition were not as effective in recategorizing. Moreover, more participants in the confirmation condition learned the target in fewer blocks compared to the complete condition. Nevertheless, the complete and confirmation conditions did not differ in responding “yes” to stimuli that contained the target feature, but the misconception was unknown (i.e, target induction stimuli). This suggests that both groups were equally effective in adopting the target feature. Finally, the complete condition performed better on the assessment. This suggests that having the opportunity to falsify in the complete condition, but not in the confirmation condition may result in better categorization in the absence of feedback. In sum, the results suggest that there is an advantage for the confirmation condition if speed of recategorizing is of primary importance. Alternatively, if performance in the absence of feedback is paramount then the complete condition has the advantage.

A similar comparison of the complete and falsification conditions follows. Both conditions were successful in learning the target. However, the complete condition performed better on Blocks 6 through 9 compared to the falsification condition. This suggests that participants in the falsification condition were not as effective in recategorizing. Moreover, more participants in the complete condition learned the target in fewer blocks compared to the

falsification condition. Additionally, the falsification condition had a higher proportion of “yes” responses for stimuli that contained the misconception, but the target was not present (i.e., misconception stimuli) compared to the complete condition. This suggests that the falsification condition held the misconception longer than the complete condition. Finally, the groups did not differ in performance in the absence of feedback (i.e., the assessment block). In sum, the results suggest that the falsification condition does not have any advantage over the complete condition. In fact, the complete condition is quicker in adopting the target conception.

So given the findings for the complete condition versus the confirmation condition and the complete condition versus the falsification condition, the falsification harmful hypothesis is best supported by the data. That is, if speed of categorizing is more strongly weighted than performance in the absence of feedback then the confirmation condition which had no falsification opportunities performed better than the two conditions that contained falsification opportunities. However, if performance in the absence of feedback is more important than speed of recategorizing then the standard hypothesis would be supported.

Ironically, the present study might serve as a falsification of some theoretical models that posit the necessity of dissatisfaction in order to produce change. Theories of conceptual change that posit the necessity of dissatisfaction might themselves need revision. Dissatisfaction is not a prerequisite for conceptual change, but one of several potential factors that can lead to recategorization. For instance, another potential factor leading to conceptual change might be the non-confrontational development of a concurrent theory that eventually surpasses its predecessor in strength of activation or perceived utility as in the Resubsumption Theory (Ohlsson, 2009, 2011).

Another model that suggests factors aside from dissatisfaction that can lead to change is the Cognitive Reconstruction of Knowledge model (see Dole & Sinatra, 1998). The model contains alternative motivating processes that can lead to conceptual change without reliance on dissatisfaction. The motivating processes include personal relevance, social context, and need for cognition. These motivating factors suggest that dissatisfaction might not be required for conceptual change.

Attempting to foster dissatisfaction for a currently held conception can lead to resistance to change (Chi & Ohlsson, 2005; Ohlsson, 2011). For example, instruction in the classroom for scientific topics known to require revision has found that direct refutation is not necessarily effective at promoting change (Vosniadou, 1994; Vosniadou & Verschaffel, 2004). Factors that lead to resistance are often couched in personal belief systems that do not necessarily subscribe to logic (Elio & Pelletier, 1997).

The present study had some limitations. Specifically, for the current study, categorization was limited to stimuli that differed on six binary attributes. More complex stimuli and more complex concepts might produce divergent results. Taking these limitations into account, the results of the present study should be carefully considered and replicated.

The reason that recategorization with target induction but not falsification was successful remains unclear. Perhaps the confirmation condition was able to increase the strength of activation for the target conception while still maintaining the misconception because learning the target did not directly interfere with the misconception in the confirmation condition. However, in situations in which the misconception returns, the learner reverts back to the misconception, as evidenced from Phase 3 performance.

Future research might investigate what processes are producing change in the confirmation condition. Future research might also investigate how switching from a series of falsification instances to a series of target induction instances and vice versa might influence the complexity of the revisions that a participant undertakes when attempting to determine what promotes oxygen resistance. Moreover, future research might explore how different types of stimuli might influence recategorical change. That is, changing the stimuli from fictitious bacteria to stimuli that have personal meaning. Additionally, studies that better mimic a classroom environment might also offer insights into what processes bring about conceptual change. Studies that are able to use multiple daily training sessions and then attempt to recategorize might help in the understanding of temporal exposure and its influences on recategorization.

Developing methods that can be used to improve student learning in the classroom are critical (Ramsburg & Youmans, 2013). The present findings suggest that dissatisfaction via falsification does not necessarily produce the most effective learning. Varying a presentation to allow for concept induction without falsification might be one way to enhance learning.

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V. REFERENCES

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TABLE I

Opportunities to Confirm or Deny Oxygen Resistance based on Condition in each Target

Training Block

	Falsification Opportunities	Induction/Confirmation Opportunities	No Inference for Either	Support for Both	Total Trials Per Block
Complete Condition	8	8	0	0	16
Confirmation Condition	0	8	8	0	16
Falsification Condition	8	0	0	8	16

Follow-up Analyses of Percentage Correct Between Conditions for Phase 2 Target Training

	Block	Complete M (SD)	Confirmation M (SD)	Falsification M (SD)	<i>t</i>	<i>p</i> - value	Cohen's d
Complete vs Confirmation	Block 6	73.96(13.24)	86.72(8.70)		4.07	< .001	1.14
Complete vs Falsification	Block 6	73.96(13.24)		57.06(14.14)	4.82	< .001	1.23
	Block 7	95.63(6.60)		83.26(20.31)	3.17	0.002	0.82
	Block 8	97.29(4.55)		84.27(21.82)	3.20	0.002	0.82
	Block 9	95.00(6.01)		86.69(19.00)	2.29	0.026	0.59
	Block 10	96.88(4.85)		92.14(14.07)	1.75	0.086	0.45
Confirmation vs Falsification	Block 6		86.72(8.71)	57.06(14.14)	9.03	< .001	2.54
	Block 7		96.09(5.77)	83.26(20.31)	3.00	0.004	0.86
	Block 8		94.53(8.51)	84.27(21.82)	2.18	0.034	0.62
	Block 9		97.66(4.04)	86.69(19.00)	2.77	0.008	0.80
	Block 10		95.57(5.36)	92.14(14.07)	1.13	0.262	0.32

TABLE III

T-tests Comparing Proportion of Responses Consistent with the Misconception

	Complete	Falsification			Cohen's
	M (SD)	M (SD)	<i>t</i>	<i>p</i> -value	d
Block 6	30.00(16.93)	67.74(26.57)	4.82	< .001	1.69
Block 7	4.07(9.94)	21.77(28.32)	3.17	0.002	0.83
Block 8	3.23(6.37)	17.74(23.00)	3.20	0.001	0.86
Block 9	3.23(6.37)	15.73(24.99)	2.29	0.010	0.69
Block 10	2.43(5.94)	6.45(12.86)	1.75	0.125	0.40

TABLE IV

Means and Standard Deviations for Proportion of Correct Responses for Target Stimuli

	Block6	Block7	Block8	Block 9	Block 10
	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)
Complete	77.92(14.19)	95.42(6.13)	97.92(5.76)	93.33(9.70)	96.25(6.69)
Confirmation	76.04(15.16)	94.27(7.35)	95.31(7.20)	97.92(6.02)	95.31(8.09)

	Block 6	Block 7	Block 8	Block 9	Block 10	Total
Complete						
Condition	5	23	1	1	0	30
Confirmation						
Condition	18	4	1	1	0	24
Falsification						
Condition	1	18	4	2	3	28

Figure 1. Example bacteria with parts labeled.

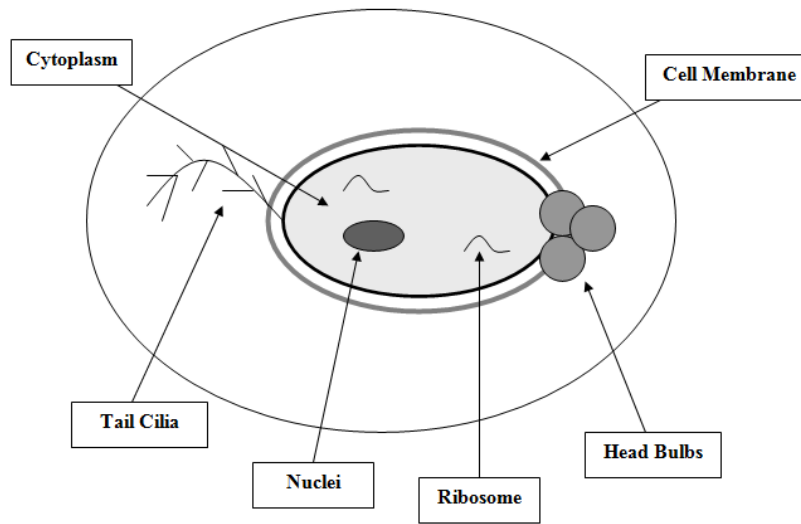


Figure 2. Example of Bacteria with and without Parts Shown.

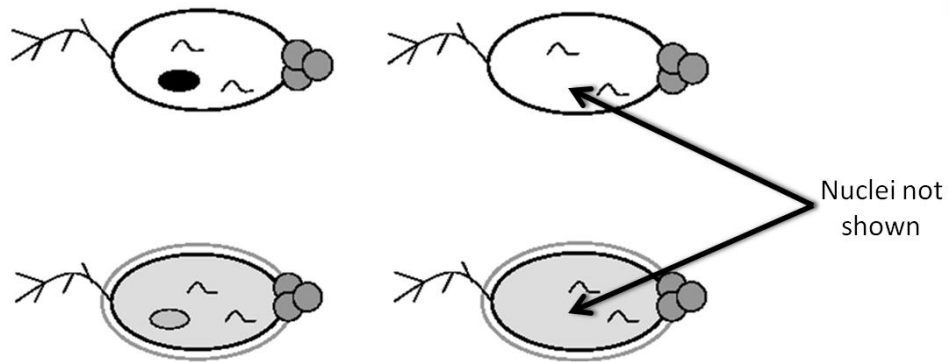
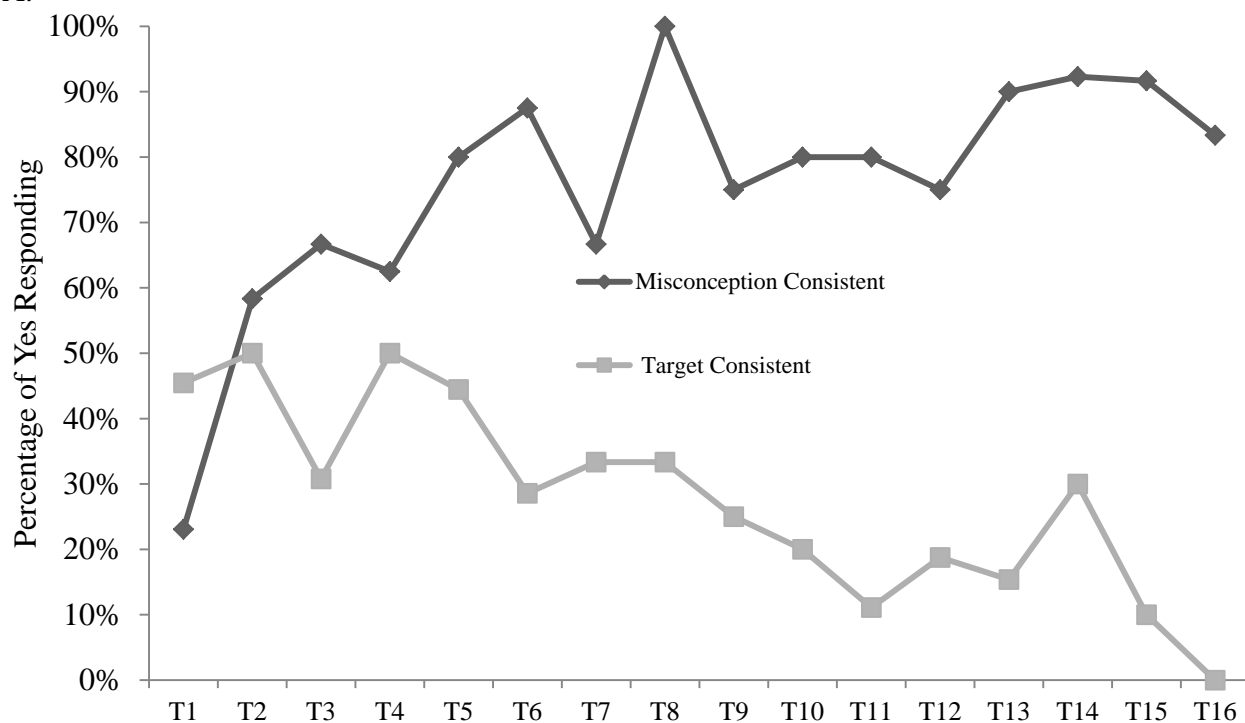
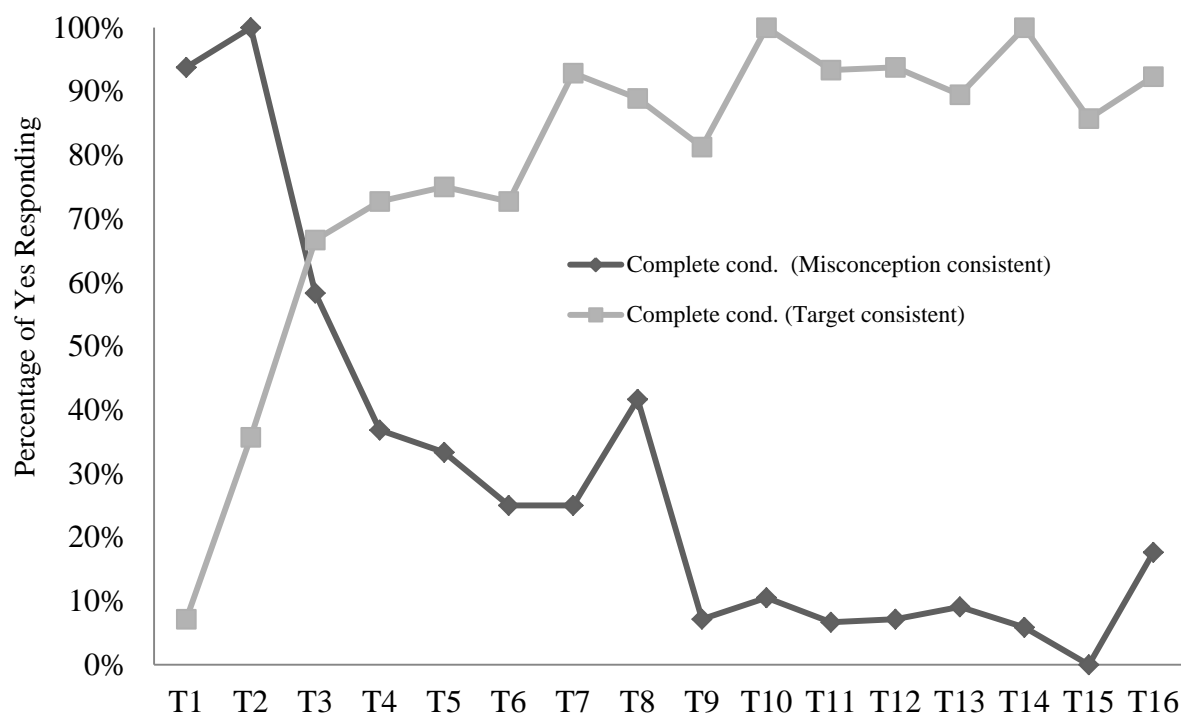


Figure 3. Response Types by Trial for the Complete Condition.

A.



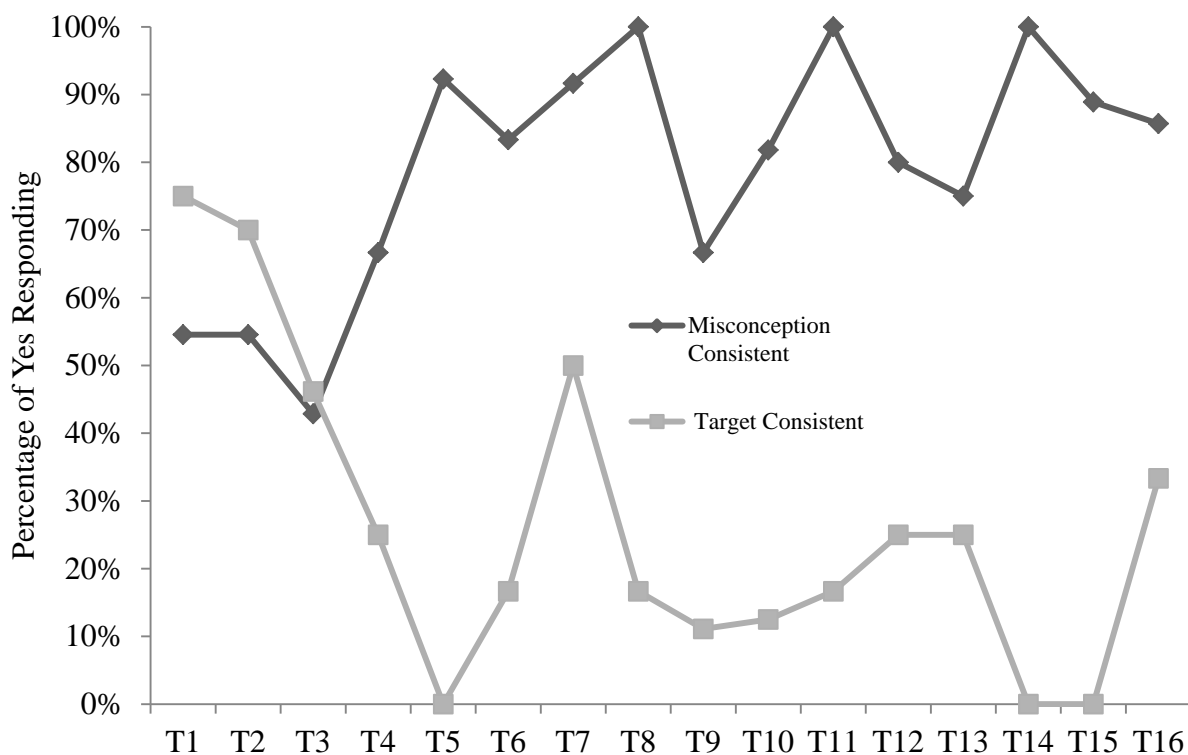
B.



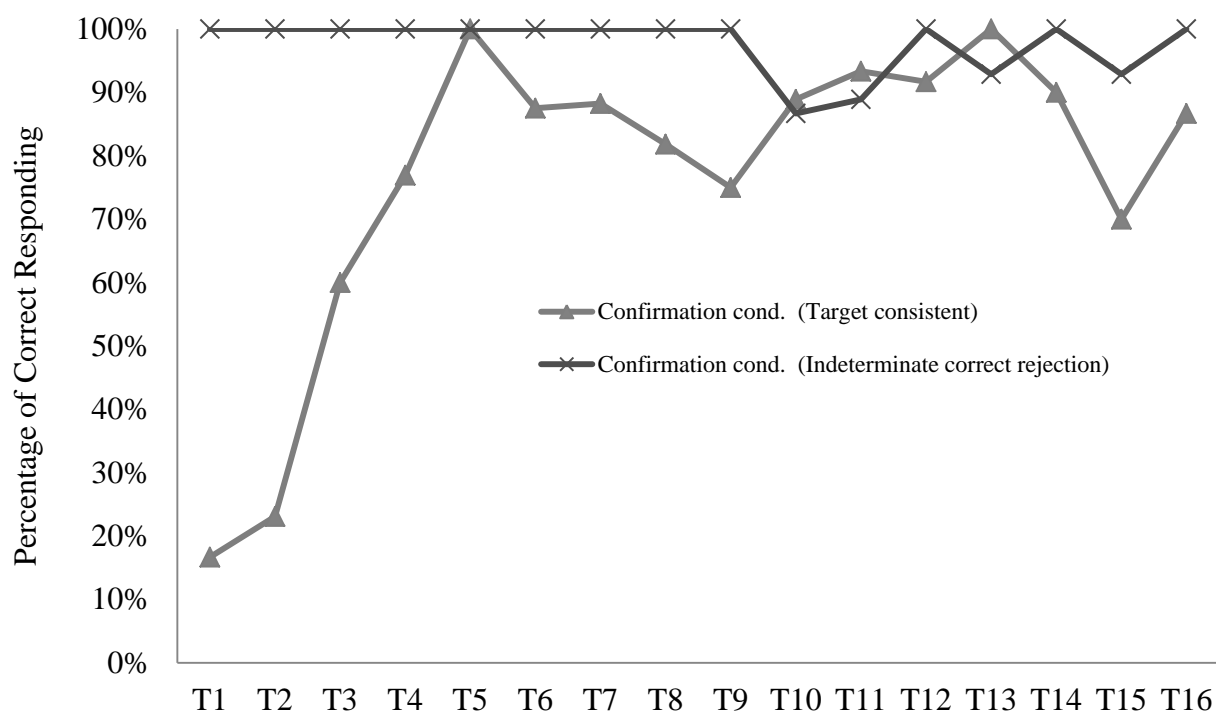
Notes: Figure A trial by trial performance for Block 1; Figure B trial by trial performance for Block 6

Figure 4. Response Types by Trial for the Confirmation Condition.

A.



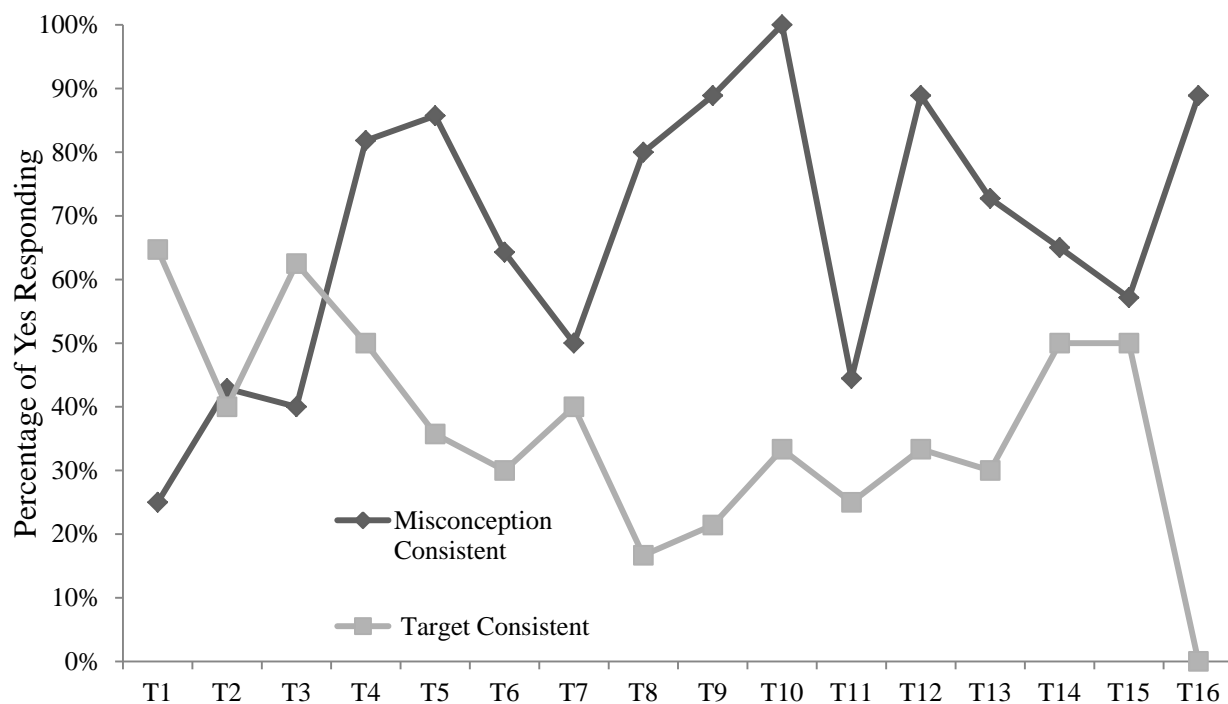
B.



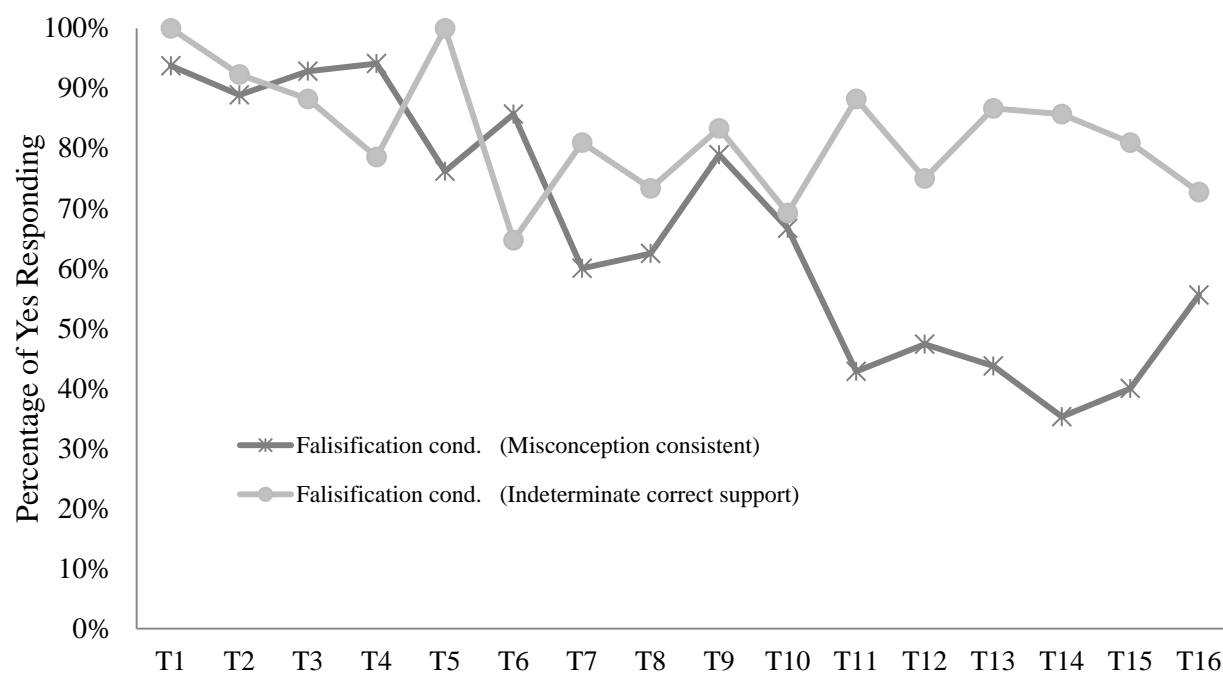
Notes: Figure A trial by trial performance for Block 1; Figure B trial by trial performance for Block 6

Figure 5. Response Types by Trial for the Falsification Condition.

A.

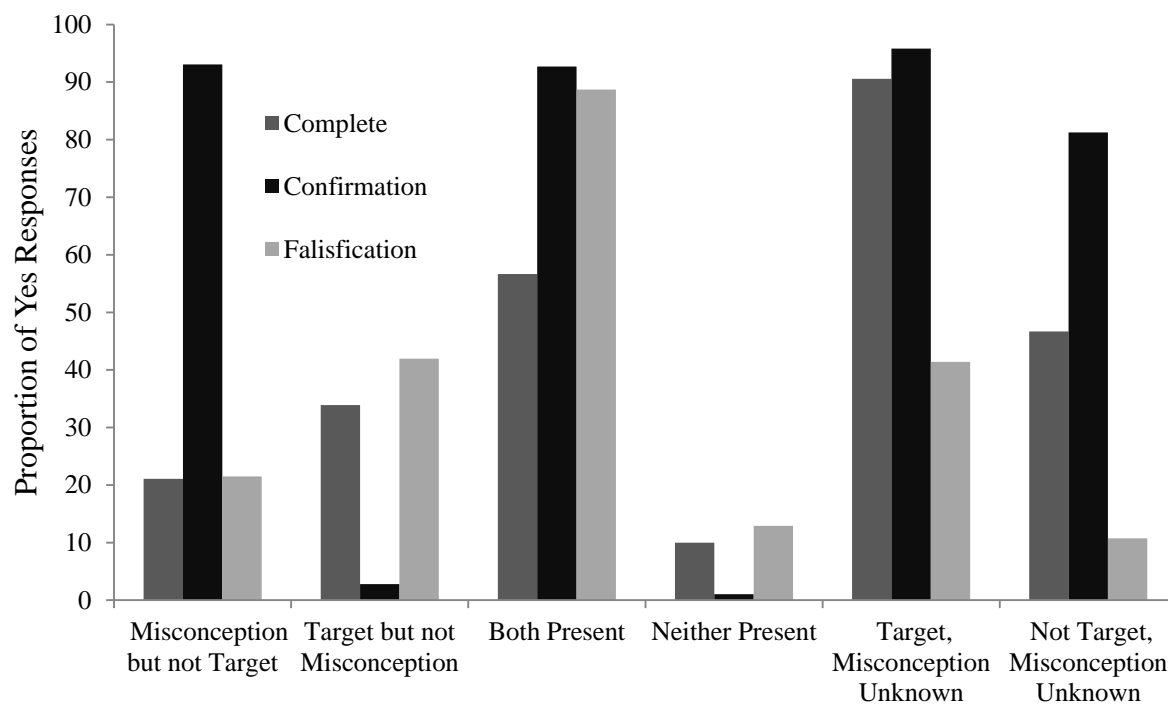


B.



Notes: Figure A trial by trial performance for Block 1; Figure B trial by trial performance for Block 6

Figure 6. Response by Stimuli Type for the Assessment Blocks.



UNIVERSITY OF ILLINOIS
AT CHICAGO

Office for the Protection of Research Subjects (OPRS)
Office of the Vice Chancellor for Research (MC 672)
203 Administrative Office Building
1737 West Polk Street
Chicago, Illinois 60612-7227

Approval Notice

Initial Review (Response To Modifications)

May 7, 2012

Jared Ramsburg

Psychology

Psychology

BSB 1021, M/C 285

Chicago, IL 60612

Phone: (661) 219-4354

RE: **Protocol # 2012-0244**

“The Role of Feedback on Learning”

Dear Mr. Ramsburg:

Your Initial Review application (Response To Modifications) was reviewed and approved by the Expedited review process on April 30, 2012. You may now begin your research.

Please note the following information about your approved research protocol:

Protocol Approval Period: April 30, 2012 - April 29, 2013

Approved Subject Enrollment #: 3,000

Additional Determinations for Research Involving Minors: The Board determined that this research satisfies 45CFR46.404, research not involving greater than minimal risk. Therefore, in accordance with 45CFR46.408, the IRB determined that only one parent's/legal guardian's permission/signature is needed. Please see "Parental Permission" below.

Performance Site: UIC

Sponsor: None

Research Protocol:

- a) The Role of Feedback in Learning; 04/23/2012

Recruitment Material:

- a) No recruitment materials will be used - Psychology Student Subject Pool procedures will be followed

Informed Consents:

- a) Feedback in Learning; Version 1; 04/23/2012
- b) Debriefing Form; Version 1; 04/23/2012

Parental Permission:

- a) A waiver of parental permission has been granted under 45 CFR 46.116(d) and 45 CFR 46.408(c) for this specific protocol; however, as per UIC Psychology Subject Pool policy, at least one parent must sign the Blanket Parental Permission document prior to the minor subject's participation in the UIC Psychology Subject Pool.

Your research meets the criteria for expedited review as defined in 45 CFR 46.110(b)(1) under the following specific category:

(7) Research on individual or group characteristics or behavior (including but not limited to research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

Please note the Review History of this submission:

Receipt Date	Submission Type	Review Process	Review Date	Review Action
03/14/2012	Initial Review	Expedited	03/16/2012	Returned To PI
04/09/2012	Response From PI	Expedited	04/11/2012	Modifications Required

04/25/2012	Response To Modifications	Expedited	04/30/2012	Approved
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Please remember to:

→ Use your **research protocol number** (2012-0244) on any documents or correspondence with the IRB concerning your research protocol.

→ Review and comply with all requirements on the enclosure,
"UIC Investigator Responsibilities, Protection of Human Research Subjects"

Please note that the UIC IRB has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

Please be aware that if the scope of work in the grant/project changes, the protocol must be amended and approved by the UIC IRB before the initiation of the change.

We wish you the best as you conduct your research. If you have any questions or need further help, please contact OPRS at (312) 996-1711 or me at (312) 996-2014. Please send any correspondence about this protocol to OPRS at 203 AOB, M/C 672.

Sincerely,

Sandra Costello

Assistant Director, IRB # 2

Office for the Protection of Research Subjects

Enclosures:

- 1. UIC Investigator Responsibilities, Protection of Human Research Subjects**
- 2. Data Security Enclosure**
- 3. Informed Consent Documents:**
 - a) Feedback in Learning; Version 1; 04/23/2012
 - b) Debriefing Form; Version 1; 04/23/2012

cc: Jon D. Kassel, Psychology, M/C 285
Stellan Ohlsson (faculty advisor), Psychology, M/C 285

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Academic History

University of Illinois at Chicago **May 2013**

Masters of Arts (MA) in Cognitive Psychology

California State University, Northridge **May 2011**

Masters of Arts (MA) in General Experimental Psychology with Distinction

California State University, Northridge (CSUN) **May 2009**

Bachelors of Arts (BA) in Psychology- Summa Cum Laude

Hagerstown Community College, Hagerstown, MD **June 2005**

Associates of Arts (AA) in Psychology Option

Academic Honors/ Awards

- Department of Psychology Presenters Award (Pending \$400) **Spring 2013**
- LAS Professional Meetings Travel Award (Pending \$500) **Spring 2013**
- Department of Psychology Presenters Award (\$300) **Spring 2012**
- Graduate College Student Presenter Award (\$275) **Spring 2012**
- Graduate Student Council Professional Meetings Travel Award (\$200) **Spring 2012**
- Sally Casanova California Pre-Doctoral Scholar (\$3000) **Fall 2010-Spring 2011**
- William Wilsoncroft Award for Excellence in General and Experimental Psychology **Spring 2011**

- CSUN Associated Students Scholarship (\$2000) **Fall 2010**
- Robert Steinmetz Research Award (\$750) **Fall 2010**
- 2nd Place Psi-Chi 22nd Annual Research Competition, Graduate Division **Spring 2011**
- 3rd Place Psi-Chi 21st Annual Research Competition, Graduate Division **Fall 2010**
- 1st Place Psi-Chi 20th Annual Research Competition, Graduate Division **Spring 2010**
- Retired Faculty Memorial Research Award (\$1500) **Spring 2010**
- Research Infrastructure for Minority Institutions Scholar Award (\$3800) **Spring 2010-Spring 2011**

- Career Opportunities in Research Affiliate Award (\$1500) **Spring 2010**
- Graduate Thesis Funding Award (\$700) **Fall 2009**
- Summa Cum Laude Recognition **Spring 2009**
- Dean's List **Fall 2003- Spring 2010**
- National Dean's List **Fall 2004**

- Opportunity Fund Scholarship (\$600)
- Phi Beta Kappa Honor Society

Fall 2004- Spring 2005
Fall 2004

Publications

- Ramsburg, J. T., & Youmans, R. J. (2013). Meditation in the higher education classroom: Meditation training improves student knowledge retention during lectures. *Mindfulness*. <http://dx.doi.org/10.1007/s12671-013-0199-5>
- Ramsburg, J. T., & Ohlsson, S. (in press). Category change in the absence of falsifying feedback. *Proceedings of the Thirty-Fifth Annual Conference of the Cognitive Science Society*.
- Ramsburg, J. T., & Youmans, R. J. (2012). Think outside the box: The effects of cognitive training on creative problem solving. *Proceedings of the Thirty-Fourth Annual Conference of the Cognitive Science Society*.
- Ramsburg, J. T., & Youmans, R. J. (2011). Cognitive training promotes academic success: An analysis of focused meditative practices on student quiz performance. *Proceedings of the Thirty-Third Annual Conference of the Cognitive Science Society*.
- Youmans, R. J., Figueroa, I. J., Ramsburg, J. T., & Kramarova, O. (2011). Promoting transfer students' success via faculty-student research collaborations. *The Center for Southern California Studies*.

Conference Presentations

- Ramsburg, J. T., & Ohlsson, S. (2013). *The effects of recategorization without falsification*. Oral presentation at the Midwestern Psychological Association Annual Meeting, Chicago, IL.
- Ramsburg, J. T., & Ohlsson, S. (accepted). *Category change in the absence of falsifying feedback*. Poster Presentation at the Thirty-Fifth Annual Conference of the Cognitive Science Society, Berlin, Germany.
- Ramsburg, J. T., & Youmans, R. J. (2012). *Think outside the box: The effects of cognitive training on creative problem solving*. Poster Presentation at the Thirty-Fourth Annual Conference of the Cognitive Science Society, Sapporo, Japan.
- Ramsburg, J. T. (2012). *The Effect of Falsifiability on Recategorization*. Oral Presentation for the University of Illinois at Chicago, Cognitive Psychology Brownbag Series, Chicago, IL.
- Ramsburg, J. T., & Youmans, R. J. (2011). *Think outside the box: The effects of cognitive training on creative problem solving*. Symposium presentation at the 91st Annual Western Psychological Association Annual Meeting, Los Angeles, CA.
- Ramsburg, J. T., & Youmans, R. J. (2011). *Cognitive training promotes academic success: An analysis of focused meditative practices on quiz performance*. Poster presentation at the 91st Annual Western Psychological Association Annual Meeting, Los Angeles, CA.
- Ramsburg, J. T., Otten, M., & Corral, D. (2011). *Can mindfulness exercises promote clutch performance under pressure in sport?* Symposium presentation at the 91st Annual Western Psychological Association Annual Meeting, Los Angeles, CA.

- Bultman, A. R., Soufi K., Ramsburg, J. T., & Youmans, R. J. (2011). *The effects of meditation on minority academic performance*. Poster presentation at the 91st Annual Western Psychological Association Annual Meeting, Los Angeles, CA.
- Ramsburg, J. T., & Youmans, R. J. (2011). *Cognitive training promotes academic success: An analysis of focused meditative practices on student quiz performance*. Poster presentation at the 33rd Annual Conference of the Cognitive Science Society. Boston, MA.
- Ramsburg, J. T. & Youmans, R. J. (2011). *Can brief cognitive training exercises improve self-regulation?* Poster presentation for the Self and Identity, Society of Personality and Social Psychology Pre-Conference, San Antonio, TX.
- Ramsburg, J. T., & Youmans, R. J. (2011). *The effects of cognitive training on creative problem solving*. Poster presentation at the 22nd Annual Research Competition Sponsored by Psi Chi, Northridge, CA.
- Ramsburg, J. T. & Youmans, R. J. (2011). *The effects of brief cognitive training on classroom performance* Oral presentation for the Research Infrastructure in Minority Institutions Regional Conference, Northridge, CA.
- Ramsburg, J. T., & Youmans, R. J. (2011). *The effects of cognitive training on creative problem solving*. Poster presentation at the 22nd Annual Research Competition Sponsored by Psi Chi, Northridge, CA.
- Ramsburg, J. T. & Youmans, R. J. (2011). *Does meditation expertise differentially affect self-regulatory functioning?* Oral Presentation at the 16th Annual CSUN Student Research and Creative Works Symposium, Northridge, CA.
- Ramsburg, J. T., & Youmans, R. J. (2010). *Can students benefit from brief cognitive training?* Poster presentation at the 21st Annual Research Competition Sponsored by Psi Chi, Northridge, CA.
- Bultman, A. R., Ramsburg, J. T., Soufi, K., & Youmans, R. J. (2010). *Applied cognitive training may enhance minority student performance*. Poster presentation at the 21st Annual Research Competition Sponsored by Psi Chi, Northridge, CA.
- Soufi, K., Ramsburg, J. T., Corral, D., Bultman, A. R., & Rutchick, A. M. (2010). *The effects of religious affiliation on utilitarian choices*. Poster presentation at the 21st Annual Research Competition Sponsored by Psi Chi, Northridge, CA.
- Ramsburg, J. T., & Youmans, R. J. (2010). *Developing a model for cognitive training*. Oral Presentation for the California State University, Northridge Psychology Brownbag Series, Northridge, CA.
- Ramsburg, J. T., & Youmans, R. J. (2010). *Enhancing attentional processes and memory: How meditation may enhance student performance*. Poster presentation for the American Psychological Association's Annual Conference, San Diego, CA.
- Ramsburg, J. T., & Youmans, R. J. (2010). *The effects of cognitive training on self-regulatory mechanisms*. Oral Presentation for the 12th Annual Sigma Xi Student Research Symposium, Northridge, CA.

Ramsburg, J. T., & Youmans, R. J. (2010). *The effects of active cognitive training on self-regulatory mechanisms*. Poster presentation at the 20th Annual Research Competition Sponsored by Psi Chi, Northridge, CA.

Ramsburg, J. T., & Youmans, R. J. (2010). *The effects of meditation on self-regulatory mechanisms*. Symposium presentation at the 90th Annual Western Psychological Association Annual Meeting, Cancun, Mexico.

Ramsburg, J. T. & Youmans, R. J. (2010). *How Zen-style meditation may enhance self-regulation*. Oral Presentation at the 15th Annual CSUN Student Research and Creative Works Symposium, Northridge, CA.

Youmans, R. J., & Ramsburg, J. T. (2010). *Group advantages in creative design*. Poster presentation for the Group Processes and Intergroup Relations, Society of Personality and Social Psychology Pre-Conference, Las Vegas, NV.

Ramsburg, J. T., Adeh, S., Fidantek, S., Garcia, J., Lavaee, N., Uchitel, F., & Youmans, R. J. (2008). *Is reaction time affected by distraction?* Poster presentation at the 16th Annual Undergraduate Research Competition Sponsored by Psi Chi, Northridge, CA.

Invited Talks

Ramsburg, J. T., & Youmans, R. J. (2010). *The effects of applied cognitive training on self-regulatory functions*. Oral Presentation for the Learning Research and Development Center Brownbag Series, Pittsburgh, PA.

Ramsburg, J. T. (2010). *The effects of active cognitive training on self-regulatory mechanisms*. Research Proposal Presentation for The Annual Retired Faculty Memorial Association, Northridge, CA.

Research Experience

University of Illinois at Chicago, Chicago, IL

August 2011-present

Graduate Student

Advisor: Stellan Ohlsson, Ph.D.

Examine the conditions in which non-monotonic change (i.e., overriding previously learned material) can occur. The basic ideas are (a) that non-monotonic change can be accomplished through feedback; (b) individual differences in cognitive processes can influence learning; and (c) for any one task, measures of learning should therefore correlate with measures of the individual differences in the relevant learning mechanisms and to the feedback given. The long-term objective of this project is to explore this approach and to demonstrate its power to the community of researchers interested in learning. Its significance rests with the possibility that this approach will provide a novel window onto cognitive change processes. The specific objective of the project is to conduct a series of studies that apply this approach.

Carnegie Mellon University, Pittsburgh, PA

June 2011-August 2011

Summer Research Assistant

Advisor: David Creswell, Ph.D.

Examine fMRI data via statistical parametric mapping (SPM) software with the intention of discovering whether a three day mindfulness retreat can promote systematic changes in brain activation during a variety of cognitive tasks compared to a rest and relaxation control condition. The processing of the data involved extensive understanding and utilization of the software package SPM. Additionally, I was charged with developing a manuscript that would highlight the key findings with the intention of submitting the results for peer-reviewed publication.

CSUN Psychology Department, Northridge, CA

August 2009- June 2011

Graduate Student

Advisor: Robert Youmans, Ph.D.

Develop research on self-regulatory mechanisms. During my first year, I examined the effects of meditation on persistence, classroom performance, and attentional processing. Based on the existing literature on meditation, and on my own personal experience as a long-term meditator, I predicted that when someone meditates instead of passively relaxing, he or she should have gains in self-regulatory functioning. The results revealed that participants in a classroom environment improved performance and participants in an experimental setting believed they improved performance. For my second year, I will be examining in my thesis the possible underlying conceptual components responsible for enhanced self-regulatory functioning and the differential time effects of cognitive training on self-regulatory functioning. Uncovering evidence that self-regulatory functioning might be amplified via meditation is of both theoretical and practical interest within the field of psychology. The findings that self-regulatory functioning can be maintained or improved would provide tangible support for the health benefits of active cognitive training (see Pagnoni & Cekic, 2007), but might also provide new clinical approaches for people who might be suffering from failures of their own self-regulation, including troubled youth, chronic dieters and smokers, and children with attention-deficit hyperactivity disorder.

CSUN Psychology Department, Northridge, CA

August 2009- June 2011

Research Assistant

Advisor: Robert Youmans, Ph.D.

I am the mentoring coordinator for a project involving a longitudinal study of student performance, academic training, and feedback variables. The purpose of the research study is to examine the effectiveness of time management feedback on student performance. Specifically, the feedback variables involve generated time management sheets, developed from data attained via randomly sent text messages, which generically asks what the students are doing 'right now'. Perceived time spent and actual time spent are not necessarily equitable, the awareness of the possible discrepancy is expected to produce positive change in student time management skills. Additionally, I am developing research interests, conducting literature reviews, applying for scholarships, data collection & analyses, and organizing my thesis project.

CSUN Psychology Department, Northridge, CA

September 2010- June 2011

Research Assistant

Advisor: Mark Otten, Ph.D.

I am currently working in Dr. Otten's sports psychology laboratory examining how mindfulness exercises might enhance sports performance. Specifically, anxiety, and in particular reinvestment of attention (purposefully endeavoring to pay attention to a skill; see Masters, Polman & Hammond, 1993), has been found in research to be detrimental to performance in sport. Interestingly, past research has shown that mindfulness exercises can reduce anxiety and promote self-regulatory functioning (Brown, Ryan & Creswell, 2007), which may carry over to athletic performance, particularly when there is pressure. This link has not yet been explored, to date, in the sport psychology literature. We are currently examining whether a mindfulness-training exercise can improve basketball free throw performance under pressure conditions. Findings may support the use of mindfulness-training exercises for the enhancement of athletic performance, particularly in high-anxiety conditions.

Sally Casanova California Pre-Doctoral Scholar

CSUN Psychology Department, Northridge, CA

August 2010

Advisor: Robert Youmans, Ph.D.

As a Sally Casanova California Pre-Doctoral Scholar, a program designed to increase the pool of potential faculty by supporting the doctoral aspirations of California State University students, I am the recipient of a funded research-internship program at a doctoral-granting institution of my choice. The research internship will take place in the summer of 2011 and last approximately 8 to 10 weeks. At the research internship, I plan to continue my research investigating how different cognitive training programs affect self-regulatory functioning.

Research Infrastructure for Minority Institutions (RIMI) Research Scholar

CSUN Psychology Department, Northridge, CA

January 2010- June 2011

Advisor: Robert Youmans, Ph.D.

RIMI is a program funded by the National Institutes of Health that was designed to generate more valid health- and mental health-related research by diversifying the pool of researchers who study health disparities. As a RIMI scholar, I am responsible for gaining experience in multiple research practices and cultivating methods for reducing health disparities. In the spring of 2010, I conducted qualitative research (grounded theory) under the advisement of Dr. Holli Tonyan, which involved utilizing qualitative interview data from students to develop a grounded theory for the relationship between student academic performance and social factors. Currently, I am conducting quantitative research (archival) under the advisement of Dr. Jill Quilici, where I am examining the multiple relationships affecting high school performance using data from the Inter-University Consortium for Political and Social Research. Additionally, I am conducting action research under the advisement of Dr. Janet Oh, which involves working with a community agency (Valley Community Clinic) to develop a Mexican-American scale for the Wisconsin

Card Sorting Task. Importantly, the RIMI program involves multiple training workshops on topics ranging from advanced statistical methods to grant writing.

CSUN Psychology Department, Northridge, CA February 2008- December 2008

Research Assistant

Advisor: Sun-Mee Kang, Ph.D.

Our research focused on emotional intelligence, and I was in charge of conducting several experiments whereby participants were tested on their ability to accurately recognize emotional facial expressions while under cognitive load. Our data showed that those with higher working memory capacity were better able to distinguish emotional expressions. To gain a better understanding of the project, I conducted an extensive literature review and participated in laboratory meetings where we worked together to brainstorm future implementations of additional social-intelligence experiments.

Teaching Experience

UIC Psychology Department, Chicago, IL

May 2013-June 2013

Teaching Assistant

Advisor: Gary Raney, Ph.D.

Teacher's assistant for a 4-week session undergraduate seminar in cognition and memory. The position involves helping students to understand core topics in cognitive psychology, grading papers. Regularly held office hours.

UIC Psychology Department, Chicago, IL

January 2013-May 2013

Teaching Assistant

Advisor: Stellan Ohlsson, Ph.D.

Teacher's assistant for an undergraduate seminar in Knowledge and Skill Acquisition. The position involves helping students to understand core topics in cognitive psychology, grading papers. Regularly held office hours.

UIC Psychology Department, Chicago, IL

August 2012- December 2012

Teaching Assistant

Advisor: Stellan Ohlsson, Ph.D.

Teacher's assistant for an undergraduate seminar in cognition and memory. The position involves helping students to understand core topics in cognitive psychology, grading papers. Regularly held office hours.

UIC Psychology Department, Chicago, IL

August 2012- May 2013

Teaching Assistant

Advisor: Cheryl Cohen, Ph.D.

Teacher's assistant for introduction to psychology course. The assistantship position involves leading a discussion section with the goal of helping students with their theoretical understanding of the basic concepts in psychology. Regularly held office hours and participated in the grading of tests and essays.

UIC Psychology Department, Chicago, IL

May 2012- June 2012

Teaching Assistant

Advisor: Benjamin Storm, Ph.D.

Teacher's assistant for an undergraduate seminar in cognition and memory. The position involves helping students to understand core topics in cognitive psychology, grading papers, and giving a guest lecture. Regularly held office hours.

UIC Psychology Department, Chicago, IL

January 2012 – May 2012

Teaching Assistant

Advisor: Ansuk Seong, Ph.D.

Teacher's assistant for statistical methods in psychology. The assistantship position involved leading two discussion sections with the goal of helping students with their theoretical and practical understanding of statistics. Regularly held office hours and participated in the grading of final tests and essays.

UIC Psychology Department, Chicago, IL

August 2011- May 2012

Teaching Assistant

Advisor: Gary Greenberg, Ph.D.

Teacher's assistant for introduction to psychology course. The assistantship position involved leading five discussion sections with the goal of helping students with their theoretical understanding of the basic concepts in psychology. Regularly held office hours and participated in the grading of tests and essays.

CSUN Psychology Department, Northridge, CA

August 2009- December 2009

Teaching Assistant

Advisor: Robert Youmans, Ph.D.

Teacher's assistant for an upper division psychology course, Experimental Psychology. I aided students in the creation of research studies and mentored students in finding the proper data analysis for their projects. Lectured classes and graded students APA research papers. Regularly held office hours.

CSUN Psychology Department, Northridge, CA

August 2008- May 2009

*Teaching Assistant**Advisor: Bradley McAuliff, Ph.D.*

Teacher's assistant for two upper division psychology courses, Social Psychology. The assistantship position involved helping students with their theoretical understanding of social psychology, developing their research projects, and answering students' questions regarding experiments discussed in class. Regularly held office hours and participated in the grading of final tests and essays.

CSUN Psychology Department, Northridge, CA**January 2009- May 2009***Teaching Assistant**Advisor: Sun-Mee Kang, Ph.D.*

Teacher's assistant for an upper division psychology course, Experimental Psychology. My primary role was to help students develop their own original research experiments. The students tested characteristics such as attraction, social networking, violence, memory, and self-perception, and I helped the students to develop their experimental designs, measures of validity, independent & dependent variables, statistical analyses, and to communicate their findings by writing research papers in the format of the American Psychological Association. Held office hours by appointment.

Hagerstown Community College, Hagerstown, MD**January 2005- May 2005***Teaching Assistant**Advisor: Thomas Beecroft, Ph.D.*

Teacher's assistant for a lower division psychology course, General Psychology. The assistantship position involved helping students with their basic understanding of psychology, and answering students' questions regarding the content discussed in class. Regularly held office hours.

Hagerstown Community College, Hagerstown, MD**August 2004- May 2005***Tutor**Advisor: Christopher Baer*

Tutor for the Hagerstown Community College after-school tutoring program for minority students at South Hagerstown High School. My primary role was to help students overcome obstacles in math, science and English.