

Are You Certain In Your Skills?
Self-Evaluations and Responses to Ambiguous Feedback

By

Danaan J. O'Donnell-Davidson

A Thesis

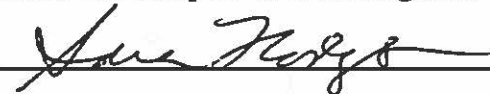
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Self Evaluations and Responses to Ambiguous Feedback

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The STEM fields (science, technology, engineering, and mathematics) have been historically male dominated, and continue to be so today. The reasons for this are numerous and complex. This study focuses on the role that self-perceptions of ability play in interpreting ambiguous feedback.

Participants consisted of 508 psychology and linguistic students recruited from the University of Oregon. Everyone learned about a “new dimension of human cognitive performance” called Integrational Complexity. Those in an “excel” condition were told that they should do well at IC, and those in an “uncertain” condition were told that their performance “on IC tasks is more uncertain and variable.”

Participants completed an “Integrational Complexity Skills Assessment.” All participants, including those in the control condition, were then informed that their IC skills were in the average range. They continued to another survey that gauged their feelings towards IC. We hypothesized that participants made to feel uncertain about their skills in IC would have more negative feelings towards the domain than either the control group or the excel group.

Participants' scores for the self-perception measure ($F(2,438)=3.96, p=0.02$) confirmed our hypothesis. We found an effect for gender as well, such that men reported significantly more positive self-perceptions with regards to IC than did women ($F(1,439)=34.44, p<0.001$). We also found that women felt their scores to be more accurate than did men ($F(1,439)= 9.64, p= 0.002$).

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Are You Certain In Your Skills? Self-Evaluations and Responses to Ambiguous Feedback

Introduction

Have you ever entered a classroom and wondered, "Am I any good at this subject?" This situation can happen to anyone, and the potential reasons for its occurrence are many, but certain people will experience these kinds of doubts more often than others. This frequency is in part predicted by demographic characteristics of the individual as well as what field of work/study the individual occupies. For example, imagine you are a woman in one of the STEM fields (science, technology, engineering and math). Most of your peers, teachers, and cited authors/researchers are male. This atmosphere may prompt you to ask, "Why are there so few women here?" which could lead to, "Are women bad at STEM?" and finally, "Am I bad at STEM?"

What makes STEM fields different from other fields? For one, the fields of science, engineering, technology and math have been historically male dominated, and continue to be so today (Blickenstaff, 2005). These fields are slow to gender equalize; the only ones that seem to have come close so far are medicine and the life sciences, and even these, at upper levels of management and academics, continue to be overwhelmingly male (Beede et al., 2010; Bickel et al., 2002). The reasons for this are many.

One reason is that some people still believe the long standing stereotype that women are biologically worse than men at the kind of thinking necessary in STEM fields (Steele, 1997), despite ample evidence to the contrary (Spelke, 2005). A meta-analysis from 2010 concluded that there was no gender difference in recent studies of mathematic performance (Lindberg, Hyde, Petersen, & Linn 2010). In 2005, Lawrence

Summers, at the time the president of Harvard University, suggested that the lack of women in STEM was due to inherent sex differences (Steele & Ambady, 2006; Zhang, Schmader & Forbes, 2009). Imagine the effects that statement could have on females in STEM, especially those attending Harvard! Even if a woman does not believe the stereotype, the mere fact that it exists can have powerful influences on her desire to remain in the field. For instance, it was shown that simply changing the décor of computer science classrooms from Star Trek posters and videogames to nature posters and phone books increased the interest of female undergraduates in computer science (Cheryan, Plaut, Davies, & Steele, 2009). The classic decorations in computer science classrooms broadcast a masculine stereotype, which discourages women from entering the field.

Besides the issues of stereotypes and male-oriented décor, STEM fields contain relatively few women professors, and hence fail to provide role models within the gender (Stout, Dasgupta, Hunsinger & McManus, 2011). Having role models who possess the same characteristics (gender, ethnicity, etc.) shows students and employees through concrete examples that they can reach the same levels of achievement as their role model (Dasgupta & Asgari, 2004; Dee, 2001). Female role models can help counteract negative stereotypes because they provide salient proof that women possess the same skills as men and can succeed within the field. Right now, this proof remains elusive to many women starting out in STEM fields because these fields consist primarily of men, both in terms of students and faculty (NSF, 2011). Even in circumstances of gender equity by number, labs usually have a male primary

investigator—communicating that women may be somewhat welcome, but only men have what it takes to climb to the top of the ladder.

Even in situations with female professors, female students can face disparate treatment. Both male and female professors may treat their female students differently than their male students, and—consciously or not—treat their work differently as well (Gunderson, 2012). Teacher’s attitudes strongly influence the views that students have of their abilities. Hence, if a teacher expects less from students, then the students oftentimes expect less from themselves. This is especially true if their teachers hold a fixed (innate) theory of math intelligence (Rattan, Good, & Dweck, 2012). If female students then receive lower grades (or assume their grades to be lower) on tests than their male counterparts, they could attribute it to their own shortcomings.

This possibility is strengthened since women tend to underestimate their performance on societally classified “masculine” tasks (Beyer, 1998). A study found that even when women performed as well as men on a science quiz, they assumed they performed worse because they believed they had worse scientific reasoning than men. Consequently, when asked to enter a science competition, they were more likely to refuse (Ehrlinger & Dunning, 2003). Women also attribute perceived poor performance to a lack of underlying ability with greater frequency than men (Felder, Felder, Mauney, Hamrin & Dietz, 1995). Taken together, this means that women may misjudge their level of performance as poor and attribute it to a lack of underlying ability, when in reality they could be performing as well—or even better—than male peers in the field. What are the consequences of this compromising atmosphere?

To start, for those that begin to doubt their abilities, self-doubt predicts self-defeating cognitive, emotional, and behavioral outcomes in the achievement realm. When people doubt their self-competence, they are more likely to self-handicap and attribute success to luck. This in turn may lead to further self-doubt (Braslow, Guerrettaz, Arkin, & Oleson, 2012). Importantly, in STEM fields, the choice to pursue a vocation is mediated by beliefs in one's ability (Hackett, 1985). Lent and colleagues found that self-efficacy predicted grades, persistence, and the range of perceived options in STEM fields (Lent, Brown, & Larkin 1986; Multon, Brown, & Lent 1991). People who think they have strong STEM abilities remain within their field, and those who do not tend to change their focus (Zhang, et al., 2009).

It is important to understand how these types of self-perceptions form because perception of performance is a better predictor of future interest than *actual* performance (Ehrlinger & Dunning, 2003). In fact, actual performance does not even necessarily predict self-ratings of abilities, especially for children (Dweck, 1986). How a person *thinks* she will perform predicts self-ratings of performance (Beyer & Bowden, 1997). When individuals are told that they have high ability in a domain, they predict that they will do better on future performances within the domain than those who have been given less positive feedback regarding their domain specific abilities (Stangor, Carr & Kiang, 1998). However, factors such as stereotypes (Bornholt, 2000; Stangor et al., 1998) and social contexts (Walton & Cohen, 2007) that favor men in certain domains—such as STEM fields—influence these expectancies. All this taken together suggests that if STEM students initially doubt their abilities, even positive performance may not change their view of self-competence, and these view will likely lead to

discontinuation within the field. However, if people expect to perform well in STEM, they will continue to rate their performance positively regardless of actual performance, and they will be more likely to remain within the field. At the same time, current stereotypes and social contexts likely prevent women from holding these positive expectancies to a comparable degree to men's.

In short, historical discrimination along with female underrepresentation in STEM fields has created a situation in which women may interpret feedback differently than their male peers. However, it is unclear whether this process is unique to women in STEM fields, or rather if anyone made uncertain about his or her abilities in a particular field might interpret feedback in a less positive light than his or her peers. Pushing this question further, is the discrimination and underrepresentation that women have experienced in STEM even necessary to create a context in which individuals interpret feedback negatively?

We designed the current study to examine how feelings of uncertainty about abilities within a given domain affect opinions towards said domain and self-perceptions of one's ability in a given domain in the face of ambiguous feedback. In this way our work furthers research exploring the experiences of women in STEM fields and how those experiences affect the gender imbalance in STEM. However, we set out to test whether similar processes might apply to any domain or situation that has created a context in which individuals question their abilities and then receive ambiguous feedback.

We chose to examine responses to ambiguous feedback specifically because ambiguous feedback is more easily misinterpreted than other forms of feedback. While

most people tend to perform in the average range (feedback that indicates an average performance is ambiguous because it does not clearly suggest a positive or negative performance), not all people respond to this performance similarly. For example, depressed individuals are more likely to interpret ambiguous feedback more negatively than non-depressed individuals (Dykman, Abramson, Alloy, & Hartlage, 1989).

Additionally, the circumstance of receiving ambiguous feedback could differ from that of receiving other feedback types. In the case of ambiguity, outside influences (e.g., stereotypes) can more easily skew recipients' interpretations of their level of achievement (Dykman et al., 1989). Vulnerable populations, who are already at risk of negative interpretation of the feedback they receive, have this hazard compounded when the feedback is of an ambiguous nature. A student, if given an "A" on a test, will know he or she performed well almost regardless of the situation, but when given a "B," that same student may now question his or her abilities.

The current study examines how feelings of uncertainty towards ability in a given domain will affect the interpretation of ambiguous feedback within the domain. We created a fictional domain ("integrational complexity") to ensure no pre-existing stereotypes can influence these results. Based on previous research (Beyer & Bowden, 1997), men may report higher scores on self-perception of ability measures than women, but gender is not expected to moderate the effects of manipulating uncertainty, described in more detail below.

Setting overall gender differences aside, the main purpose of this study is to find out whether *anyone*, when made to feel uncertain about his or her skills in a given domain and then provided with ambiguous feedback, will have more negative feelings

towards the domain in terms of self-perceptions, future interest, perceptions of the domain, and perceptions of feedback. If uncertainty affects men and women alike, this suggests that women's underrepresentation in STEM is not due to innate ability differences, but instead a normal response to uncertainty that is created for them in male dominated/oriented fields.

To test this we assigned participants to one of three conditions where their performance expectations in a novel domain were manipulated (uncertain expectation, control (no expectation), or expectation to excel). Everyone received the same ambiguous results and we then measured participants' self-perceptions and feelings towards the fabricated domain. We hypothesize that participants made to feel uncertain about their skills in a given domain would have more negative feelings towards the domain than either a control group or a group told that they would likely excel. We included a control condition (where no performance expectancies were introduced) in order to better understand whether uncertainty *hurts* self-perceptions or rather if expecting to excel *boosts* self-perceptions. We hypothesize that both will be the case.

Method

Participants

A total of 508 psychology and linguistic students recruited from the human subjects pool at the University of Oregon participated in this study for class research credit. Due to the online nature of the experiment, students could participate in the study at any time and place, at a computer of their choosing. Out of the 508 total participants, 73.6% were female and 26.4% male. Ages ranged from 18 to 43 ($M=19.63$, $SD=2.53$); most participants were white (72.9%) and native English speakers (92.9%). Data were

excluded from 57 individuals for failure to pass the manipulation check (i.e., they could not identify what condition they had been assigned to), 6 individuals who expressed suspicion (discussed below), and another 5 individuals who did not complete the study, leaving a total sample of 440 individuals.

Procedure

After reading an informed consent page and completing a basic demographic survey, participants were brought to a screen on the computer explaining the purpose of the study. Participants were told that the study was about “a new dimension of human cognitive performance” that has gained psychologists’ interests as electronic and online communication has increased. From this point on, all information given to the students about this “cognitive dimension” was fictitious. This deception created an opportunity for participants to form feelings towards a domain they had never previously encountered, thus ensuring they had no preconceived notions regarding how they would perform or whether they would belong. The cognitive dimension was called Integrational Complexity (IC for short). Participants read that IC skills were important for multitasking and electronic media skills and that IC skills were associated with college success. After reading the description of IC, the procedure diverged for the experimental and control conditions. In the control condition, participants continued straight from the description of the domain of IC to the “Integrational Complexity Skills Assessment” (described below).

In the experimental conditions, prior to the skills assessment, participants’ expectations for how they would perform on the assessment were manipulated. Participants in the experimental conditions were told that when they first signed up to

be a part of the human subjects pool, among the background measures they initially completed were measures that could predict how they would perform on tests requiring IC skills. They were also told that previous research using these measures had identified two types of cognitive profiles: “Group C,” who tend to perform well on IC tasks, and “Group X,” whose performance “on IC tasks is more uncertain and variable.”

Participants were told that because they had already filled out the general survey, their cognitive profiles could be calculated to see which group they were in. After clicking to continue, a “loading” screen appeared in order to give the impression that their profile was actually being computed. At this point participants in the experimental condition were randomly assigned to one of the two IC groups (i.e., Group C or Group X) and reminded of what that profile meant for IC performance (i.e., tendency to excel or uncertain performance). Participants in the control condition were not told anything about a preliminary measure that predicted their IC skills; nor were they told anything about the two IC groups. After receiving the cognitive profile information, participants were told that “To help us learn more about how this cognitive profile is related to IC, next you will take a test of your IC skills.”

Participants in all conditions completed the bogus “Integrational Complexity Skills Assessment.” This assessment consisted of 21 questions that were designed to have no obvious correct answers so that participants would be unsure of how they were performing. Some of the questions asked for the participant to make a comparison judgment between two pictures (e.g., participants were shown pictures of two different renderings of trains in motion and asked “Which train appears to be moving faster to you?”). Other questions asked for the participant’s opinion on an optical illusion (e.g.,

participants were shown a picture of a spinning dancer and asked, “Which direction does the dancer appear to be spinning?”).

After they finished the IC assessment, participants waited while the computer ostensibly processed their results. All participants received the same feedback regardless of condition. They were shown a graph that displayed the distribution of IC skills in the general population with three areas labeled: low competency, average, and high competency (see figure in the Appendix). The participant’s score was marked as a red line in the center of the graph—clearly a very average score—and they were told that:

Your Integrational Complexity skills are in the average range. Because they are not in the high competency range at this point, many Integrational Complexity tasks would challenge you, but your performance suggests that with training and practice, you could improve substantially at Integrational Complexity.

After receiving feedback on their performance participants were told that they would answer questions about their experiences and the feedback they received.

Measures

As a manipulation check, first participants were asked which cognitive profile they had been assigned to before completing the IC assessment: Group C, Group X, or no profile provided (i.e., what participants in the control condition should have responded, as they received no information regarding previous IC performance and were not assigned any profile group).

Next, participants answered 10 questions created to gauge their responses towards IC and their self-evaluations of their IC skills. Each of these questions fell into one of four categories: self-perceptions, future interest, perceptions of IC, and perceptions of feedback. Following each of the items, participants were given a sliding

bar scale that was anchored with “1” at the low end and “7” at the high end. The specific items are described below.

Self-perceptions: Participants were asked, “Overall, how good do you think your Integrational Complexity skills are?” with the sliding scale anchored by “poor” and “superb.” They were also asked, “When you think about your Integrational Complexity skills compared to other college students, where do you think your relative standing is?” with the sliding scale anchored by “a great deal worse than other college students” and “a great deal better than other college students.”

Future interest: Participants were asked to, “Imagine that a course offered on campus was good at helping you improve your Integrational Complexity skills. How likely would you be to take that course?” with the sliding scale anchored with “a great deal less likely to take it” and “a great deal more likely to take it.” Participants were also asked, “Imagine that the university offered workshops designed to help students improve Integrational Complexity skills as part of a ‘college to career preparation program.’ How interested would you be in taking such a workshop?” with the sliding scale anchored with “not at all interested” and “very interested.”

Perceptions of IC: Participants were asked three questions about their perceptions of IC. The first was “To what extent do you think you could improve your Integrational Complexity skills?” (with the sliding scale going from “I couldn’t improve them at all” and “I could improve them drastically”). They were also asked, “To what extent do you think your level of Integrational Complexity skill is something you are born with?” (with the sliding scale going from “not at all” to “entirely”) and “To what extent do you think your Integrational Complexity skills are important to your future

success both in college and your chosen career?” (sliding scale ranging from “not at all important” to “very important”).

Perceptions of feedback: Participants were asked three questions about their perceptions of the IC feedback they received. These questions included “How positive was the feedback you received on your Integrational Complexity test performance?” (sliding scale ranging from “not at all positive” to “entirely positive”); “Do you think the feedback you received on your Integrational Complexity test performance is accurate of your actual skill level?” (sliding scale ranging from “not at all accurate” to “entirely accurate”); and “How much did the feedback you received on your Integrational Complexity test performance motivate you to improve your skills in the future?” (sliding scale ranging from “not at all” to “very much”).

A final, open-ended question asked, “Do you have any additional comments or concerns you'd like to share with us?” This was intended to allow participants to report any suspicions they had regarding the study. Three participants reported that IC probably was not real and that the study must be measuring something else. Two of these participants indicated that the optical illusion questions were what gave it away, and the third managed to ascertain that the average feedback was probably fake and given to all participants. Only two participants identified the false nature of the results. In total, the data of six participants were excluded based on their responses to this question.

After completing the dependent measures, participants were provided with a written debriefing form. It was explained to them that IC is not a real cognitive dimension, that the participant's assigned cognitive profile was fabricated as a

manipulation in the study, and the IC assessment they took and the feedback they received were false. Participants were thanked for their time and asked not to talk about the purposes of the study with anyone.

Results

Self-Perception:

The two items designed to assess Self-Perceptions were highly correlated ($r=.52$, $p<.001$), thus these items were averaged to form a composite. We hypothesized that the performance expectations would affect participants' Self-Perceptions of their IC skills. To test this, we used analysis of covariance (ANCOVA) to determine whether expectation condition (Excel v. Uncertain v. Control) and gender (Male v. Female) impacted Self-Perceptions, with GPA as a covariate in this analysis because GPA is a real measurement of student competence, and we wanted to ascertain that performance expectations would predict Self-Perceptions of IC above and beyond performance as a student.

Consistent with our hypotheses, this analysis revealed a significant main effect of condition ($F(2,438)= 3.96$, $p= 0.02$). We used post-hoc comparisons to break down this omnibus effect. As displayed in Figure 1, the uncertain condition ($M= 4.47$, $SD= 0.78$) reported significantly lower average scores than the excel condition ($M= 4.72$, $SD= 0.75$) on Self-Perceptions ($p=0.003$). The average score from the control group ($M= 4.58$, $SD= 0.75$) fell between the uncertain and excel conditions and was not significantly different from either. There was also a main effect of gender (see Figure 1). On average, males ($M= 4.91$, $SD= 0.85$) reported more positive Self-Perceptions

than females ($M= 4.46, SD= 0.70$), $F(1,439)= 34.44, p< 0.001$. There was no interaction between gender and condition ($F(2,438)= 0.03, p= 0.97$).

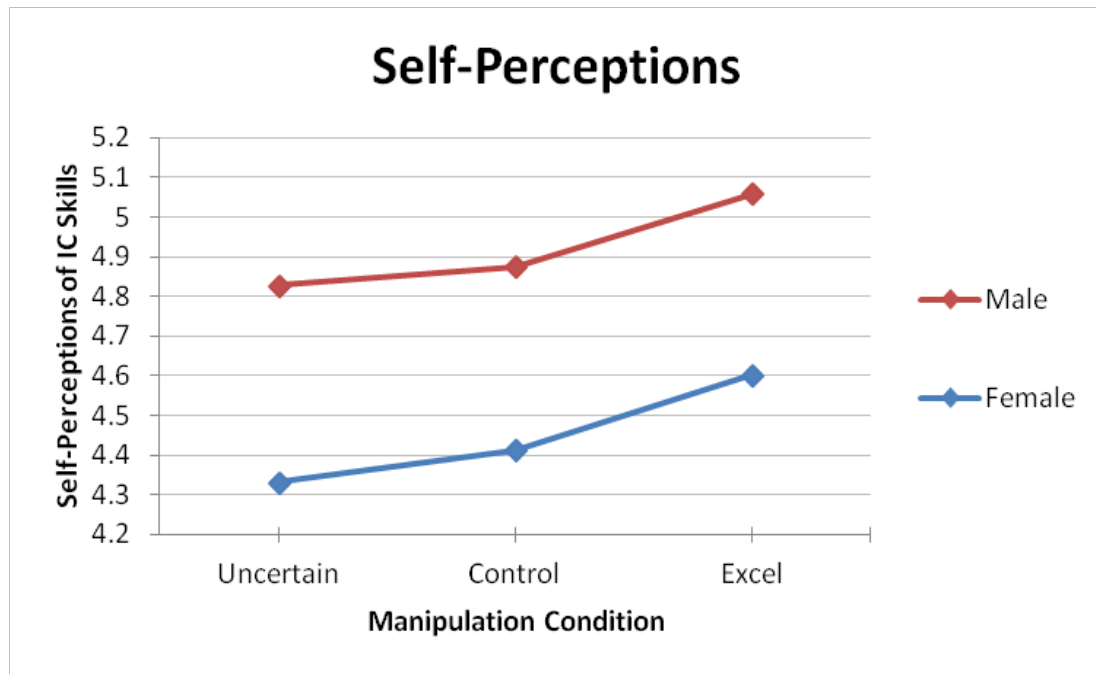


Figure 1. Self-perceptions of IC skills. This figure illustrates participants' self-perceptions of IC skills after receiving ambiguous feedback.

Future Interest

The two items designed to assess Future Interest were highly correlated ($r=0.63, p<0.001$), thus these items were averaged to form a composite. We hypothesized that performance expectations would affect participants' Future Interest in IC. Those in the uncertain condition would report lower scores for Future Interest, while those in the excel condition would report higher. To test this, we used analysis of variance (ANOVA) to determine whether expectation condition (Excel v. Uncertain v. Control) and gender (Male v. Female) impacted Future Interest. Future Interest was not significantly affected by either gender ($F(1,439)=0.39, p= 0.53$) or condition ($F(2,438)=0.72, p=0.49$). Additionally, no interaction between gender and condition

was found ($F(2,438)=0.013, p= 0.99$). This suggests that all participants, regardless of gender and condition, responded similarly to the measures of Future Interest.

Perceptions of Integrational Complexity:

Out of the three items designed to measure Perceptions of IC, the two measuring Innateness and Improvability were not highly correlated ($r= -0.03, p= 0.531$), so they were analyzed separately. The third item was measuring something different—the importance of IC to Future Success—and was never intended for joint analysis.

However, we predicted the same pattern of results for all three measures: Those in the uncertain condition would report lower scores for Perceptions of IC, while those in the excel condition would report higher. To test whether expectation condition (Excel v. Uncertain v. Control) and gender (Male v. Female) impacted Perceptions of IC, we ran separate analyses of variance (ANOVAs) on Improvability, Innate Ability, and Future Success.

The analysis of Improvability revealed that neither gender ($F(1,439)=3.53, p= 0.23$), nor the interaction of gender and condition ($F(2,438)=0.37, p= 0.75$) had an effect. However, Improvability was significantly affected by condition, $F(2,438)= 3.53, p= 0.30$. We used post-hoc comparisons to break down this omnibus effect. As displayed in Figure 2, the excel condition ($M= 4.83, SD= 1.18$) reported significantly lower average scores than the control condition ($M= 5.32, SD= 1.05$) on Improvability ($p< 0.001$). The average score from the uncertain condition ($M= 5.03, SD= 1.11$) trended towards significantly different from the control group ($p= 0.053$). Therefore, participants in both experimental conditions, but especially the excel condition, were

less likely to feel they could improve their Integrational Complexity skills compared to those in the control group.

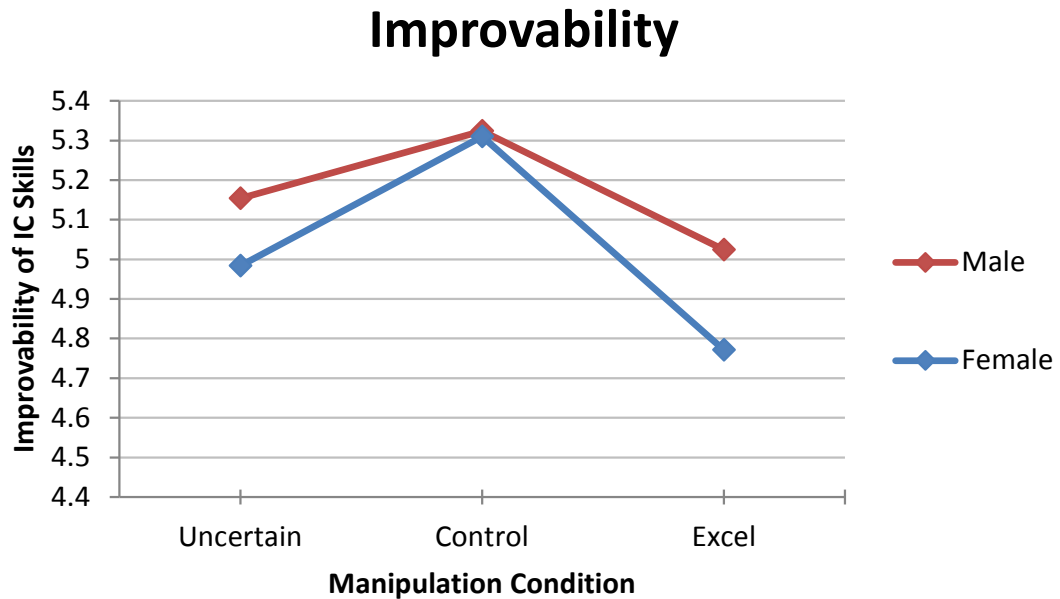


Figure 2. Improvability of IC skills. This figure illustrates how improvable participants felt their IC skills were after receiving ambiguous feedback.

Next, analysis revealed that neither gender ($F(1,439)= 0.16, p=0.69$) nor condition ($F(2, 438)= 2.44, p= 0.09$) had an effect on perceptions of Innate Ability. However, Innate Ability perceptions were significantly affected by the interaction of gender and condition ($F(2, 438)= 4.22, p= 0.015$). As displayed in Figure 3, in the uncertain condition women ($M=3.57, SD=0.11$) reported lower average scores than men ($M=4.08, SD=0.17$), but in the control condition women ($M=3.76, SD=0.16$) reported higher scores than men ($M=3.29, SD=0.21$), and in the excel condition women ($M=3.83, SD=0.12$) and men ($M=3.95, SD=0.19$) reported very similar scores.

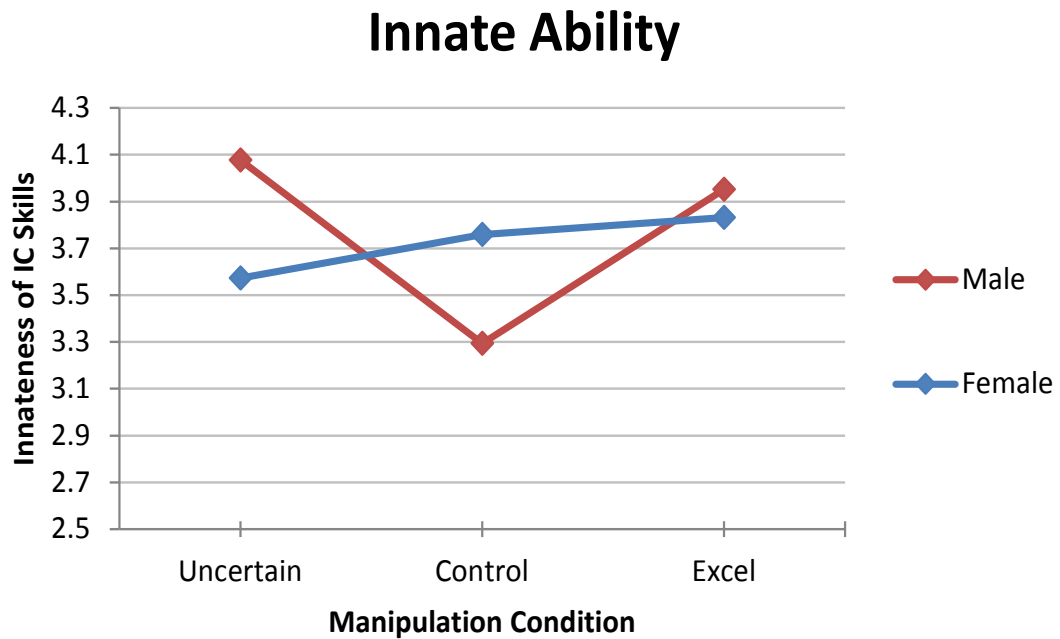


Figure 3. Innateness of IC skills. This figure illustrates how innate participants felt their IC skills were after receiving ambiguous feedback.

Neither of the main effects nor the interaction were significant for the Future Success item.

Perceptions of Feedback:

We hypothesized that performance expectations would affect participants' Perceptions of Feedback they received. Those in the uncertain condition would report lower scores for Perceptions of Feedback, while those in the excel condition would report higher. To test this, we used analysis of variance (ANOVA) to determine whether expectation condition (Excel v. Uncertain v. Control) and gender (Male v. Female) impacted Perceptions of Feedback. The three Perceptions of Feedback items: Positivity, Accuracy, and Motivation were each analyzed individually because they addressed different aspects of participant's perceptions of their feedback.

The analysis of Positivity of IC feedback revealed that neither gender ($F(1,439)=1.42, p=0.24$), condition ($F(2,438)=0.39, p=0.68$), nor the interaction between gender and condition ($F(2,438)=1.20, p=0.30$) significantly affected Positivity. This suggests that participants, regardless of gender and condition, did not differ in their Positivity towards IC.

The analysis of Accuracy revealed that there was a main effect by gender. On average, women ($M=4.23, SD=1.41$) reported that the feedback was more accurate than did males ($M=3.74, SD=1.46$), $F(1,439)=9.64, p=0.002$ (see Figure 4). No effect was found for either condition ($F(2,438)=0.08, p=0.93$) or the interaction between gender and condition ($F(2,438)=0.002, p=1.00$).

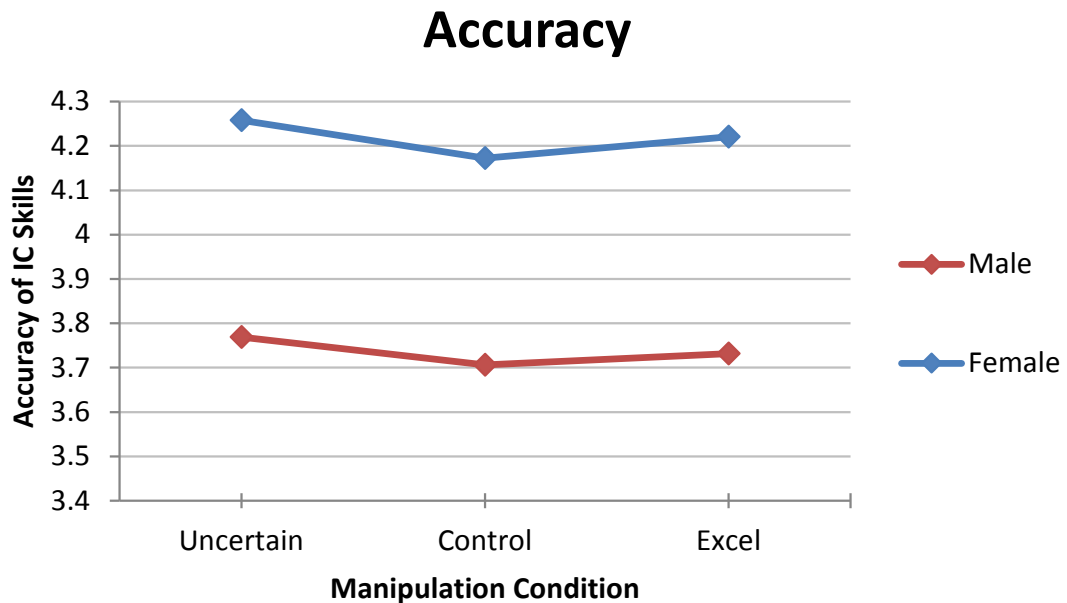


Figure 4. Accuracy of IC skills. This figure illustrates how accurate participants felt their IC skills were after receiving ambiguous feedback.

The analysis of the Motivation item revealed that neither gender ($F(1,439)=0.18, p=0.67$), condition ($F(2,438)=0.06, p=0.94$), nor the interaction between gender and

condition ($F(2,438)=0.06, p= 0.94$) had a significant effect on how much the feedback affected participants' motivation to improve their IC skills. This suggests that participants, regardless of gender and condition, reported similar scores on the measures of how feedback affected Motivation.

Discussion

Recall that we hypothesized that individuals made uncertain about their abilities in a domain would feel more negative towards the domain, while individuals led to believe that they would excel would feel more positive towards the domain—compared to those given no expectancies. Our results for self-perceptions of IC ability confirmed this hypothesis (Figure 1). Regardless of gender, participants told that they should expect to excel at IC reported more positive self-perceptions of their abilities even after their results indicated an average performance, while those made to feel uncertain reported less positive self-perceptions.

In addition, while we hypothesized that men and women should respond similarly to the manipulation of their performance expectations (lowest for the uncertain condition and highest for the excel condition), we recognized that men and women could potentially differ overall in their responses to questions that addressed IC abilities (due to the tendency for women to respond more humbly). Consistent with this, self-perceptions of IC skills were affected by the performance expectation, but across the board, men rated their self-perceptions of IC abilities significantly higher than did women. The results from the current study are consistent with previous research that shows men tend to report higher ratings of achievement than women (Felder et al.,

1995). Our analyses of participants' ratings of their feedback showed that women also felt the feedback they received to be significantly more accurate than did men.

This combination of findings creates a troubling pattern. It seems that, compared to men, women both under-rate their performance and feel that ambiguous feedback is accurate. As discussed earlier, retention within STEM fields is largely dependent upon self-perceptions, and women feeling that they are merely average may not be enough to keep them in the field. It seems likely that men feel their results under-represent their actual ability, considering that they reported lower scores for feedback accuracy and higher scores for self-perception than women. In fact, if men felt their feedback was inaccurately low, that could be the cause for their higher self-perception scores. Future work testing whether men's accuracy ratings were driven by their belief that their scores were low would lend strength to this interpretation of the findings in the current study.

These two results—when combined—help paint a picture for why women leave STEM fields. The field presents them with an atmosphere that promotes feelings of uncertainty with regards to ability, and then, when presented with ambiguous feedback, they feel that this feedback is accurate. Most people do not strive for “average”, and when women receive this feedback, it is not surprising that they choose to pursue another vocation. For men in STEM, the situation is quite different. They do not face a compromising atmosphere; if anything, they are encouraged by societal stereotypes of men's competence at math and science. When they do receive ambiguous feedback, they may dismiss it as inaccurate.

Another interesting set of results emerges when looking at how participants reacted to being given information about their skills before the assessment. People who

were given no information felt more capable of improving their IC skills than people who were given information—regardless of whether they were told that it was uncertain how they would perform or whether they were led to believe they would excel (Figure 2). It seems that participants who were given a profile may have had their abilities anchored by these assigned profiles and thus felt there was less possibility to improve those skills.

These findings build upon previous research by Cimpian, Mu, and Erickson (2012) that addressed children’s task performance after being linked to a social group. They found that 4- to 7-year-olds who were told that “boys are good at this game” performed worse “regardless of whether the children themselves belonged to that group” (Cimpian et al., 2012). They hypothesized that this exposure to a stereotype led to the children adopting entity theories – that is, theories that skills in this domain are innate and fixed. Our results suggest that exposure to cognitive profiles may also lead to an adoption of entity theories, and can even do so for adults.

A similar pattern of results presented itself in the innate ability item, but only for men. Men who were given information about their abilities beforehand rated IC as being the result of innate talent much more than males who were not given any information about their abilities. It appears that men, by being assigned a cognitive profile, were led to believe that IC abilities were innate, whereas women were not. This strengthens a case for the formation of entity theories, but raises the question of why men and women would differ. Perhaps men feel that if a human quality can be measured (e.g. IQ), it is innate.

We originally hypothesized that manipulating how participants' felt about their abilities would affect how much future interest they held towards IC. While we didn't confirm this hypothesis, we know based on previous literature that for women in STEM, the choice to remain within the field is dependent upon positive beliefs in one's abilities (Hackett, 1985; Lent et al., 1986; Multon et al., 1991), and the current study shows that feeling uncertain about your abilities, and then receiving ambiguous feedback, will result in more negative self-perceptions within the domain. In addition, perhaps it should not surprise us that we found no results for future interest because this study was based around a single event, whereas underrepresented groups face these conditions on a continuous basis.

One potential limitation is that existing societal stereotypes could have affected the outcomes of this study, despite the fact that a new domain—Integrational Complexity—was created solely for the purpose of minimizing this potential. However, one of the largest components of IC was described as multitasking ability, which people correctly identify as favoring women (Stoet, 2013). If pre-existing stereotypes for this skill were to have affected this study, we should have seen women report higher scores in self-perception than men.

Individuals uncertain of their abilities, after receiving ambiguous feedback, feel these abilities cannot be improved. Considering that participants made to feel uncertain about their abilities perceived their abilities as significantly lower than did those who were told they would excel, this result is concerning. Studies examining how to counteract these results would be of interest.

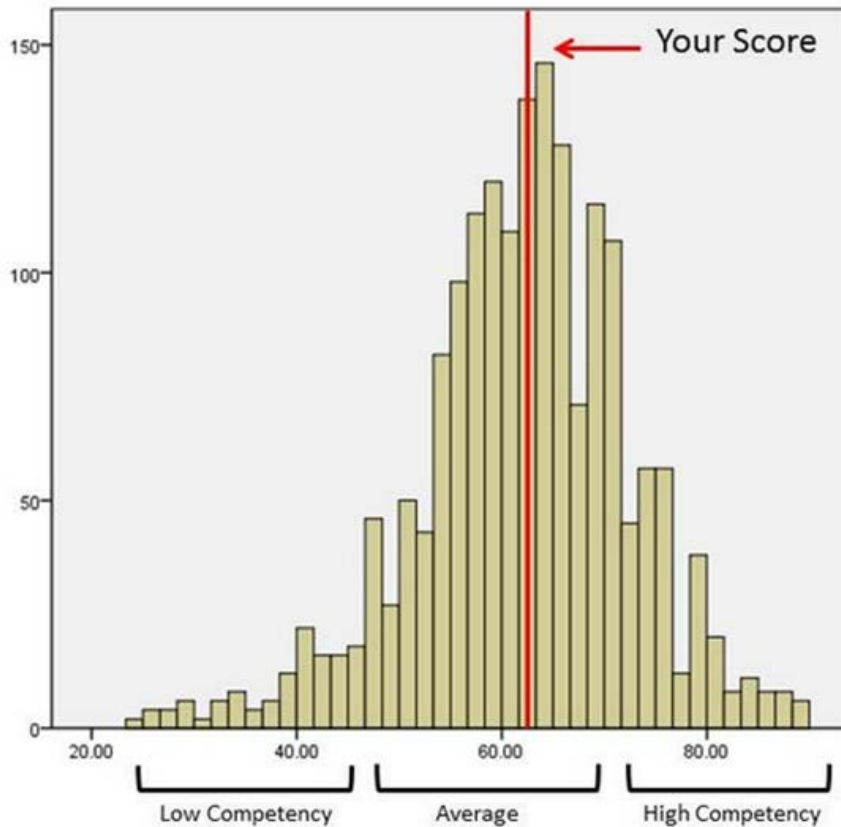
A similar study to the current one, but using multiple delivery methods to influence participants' opinions regarding their abilities, instead of just cognitive profiles, could give insight into why individuals who were given information about their abilities (uncertain or positive), reacted differently to the improvability measures and, in the case of men, to measures of innate ability. The potential study's manipulation would occur at the same time as it did in this study, but instead of varying cognitive profiles, it would vary the delivery method of information—cognitive profile would be just one of these conditions. For example, one condition could be the opinion from their academic advisor (e.g., “Based on your degree audit, your academic advisor (name) thinks you will perform well at IC”). Such a study could address the question of whether all forms of delivery affect people in the same way. We hypothesize that impersonal delivery methods (e.g. cognitive profiles and stereotypes) might feel outside of a participant's control, and therefore would reduce perceptions of improvability further than more personal feedback methods (e.g. a teacher's opinion).

Our results showed that if people were led to believe they had strong abilities within a domain, they in turn felt more positive about their abilities after receiving ambiguous feedback. Conversely, if made to feel uncertain about their abilities, they perceived these abilities as low after seeing their feedback. Right now, atmospheres exist that make specific groups of people uncertain about their abilities (e.g. women in STEM fields). In order to give students and others the highest self-perceptions possible, procedures could be put in place to reassure individuals of their abilities before tests. Ideally, this would create a situation in which students with differing group

characteristics (race, gender, ethnicity and sexual orientation) would respond similarly to ambiguous feedback.

The fact that women—on average—underrate their performances compared to men, should be circulated. The simple act of spreading this knowledge could potentially assist women in reevaluating their abilities, and help college advisers or other professionals give relevant advice. As previously mentioned, the choice to pursue a vocation in STEM fields is mediated by beliefs in one's ability (Hackett, 1985; Lent et al., 1986; Multon et al., 1991). If women are underestimating their STEM abilities, this may decrease their likelihood of continuing in STEM fields. An effective campaign promoting the gender differences in ability judgment could have a broad impact on self-perceptions and a specific influence on retention rates of women in STEM.

Appendix



The red bar on the graph below represents your results and locates them within the average distribution of IC scores in the adult U.S. population (including college students).

Performance Feedback:

Your Integrational Complexity skills are in the average range. Because they are not in the high competency range at this point, many Integrational Complexity tasks would challenge you, but your performance suggests that with training and practice, you could improve substantially at Integrational Complexity.

This figure illustrates the ambiguous feedback given to all participants after their completion of the IC assessment.

Appendix ii

| Dependent Variable | Grand Mean | Standard Deviation |
|--------------------|------------|--------------------|
| Self-Perception | 4.59 | 0.77 |
| Future-Interest | 4.12 | 1.33 |
| Innate Ability | 3.75 | 1.24 |
| Improvability | 5.01 | 1.14 |
| Future Success | 4.61 | 1.37 |
| Positivity | 4.29 | 1.11 |
| Accuracy | 4.09 | 1.44 |
| Motivation | 3.91 | 1.53 |

Table 1. Dependent variable grand means and standard deviations.

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