The Relationship Between The Dunning-Kruger Effect and Competition Entry

Debra Shteinberg

Wagner College

Abstract

Studies show that most people are overconfident about their own relative abilities, even when these abilities are unsubstantiated. Overconfidence plays an important role in a person's decision to enter into a competition and this decision can have a significant effect on economic behavior. In the present study, 30 Wagner College students were asked to answer a 10 question quantitative reasoning questionnaire with five subsequent questions that asked them how difficult they thought the questionnaire was, to compare how they think they scored on this questionnaire to other college students based on percentile rank, and to note how many questions out of 10 they think they answered correctly. Participants were also asked if they would like to enter their scores into competition with other Wagner College students and if they would like to enter their scores into competition with Harvard University students. The relationship between overconfidence and entry into competition were then analyzed. Evidence of overconfidence was present, but the results did not support the hypothesis that the proportion of overconfident Wagner students who enter into a competition with other Wagner students is greater than the proportion of overconfident Wagner students who enter into a competition with Harvard students. Implications of this study and future applications of the model are discussed.

Keywords: Dunning-Kruger effect, overconfidence, quantitative reasoning, competition economic behavior

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Beliefs about one's abilities are an important ingredient to making decisions. Beliefs that are misinformed by a person's own overconfidence, however, can lead people to make decisions with disastrous consequences. The Dunning-Kruger effect explains why people are overconfident, particularly when they lack the very abilities they believe they possess. The Dunning-Kruger effect is an observation recognizing that incompetent individuals, or those who have low levels of ability in a particular area, tend to have high levels of confidence in this ability (Kruger & Dunning, 1999). On the other hand, individuals who are more competent tend to have lower levels of confidence in their ability than those who are incompetent. Overconfidence occurs when an individual's certainty that their predictions are correct exceeds the accuracy of these predictions (Simon & Houghton, 2003). When people are incompetent in the strategies they choose to reach success, they suffer a dual burden: They not only reach wrong conclusions, but they are not competent enough to recognize their own mistakes.

Studies show that most people are overconfident about their own relative abilities, and unreasonably optimistic about their futures (Camerer & Lovallo, 1999). Individuals are overconfident in their everyday lives, for example, people report themselves to be above average in driving ability, their ability to get along with others, and their chances of obtaining jobs that they like (Moore & Cain, 2007). Overconfidence plays a significant role in people's decisions to enter competitions. People compete all the time, whether they notice it or not. They contend with others for top grades, jobs, trophies, and friends. It is optimal to enter into competitive environments in which they are certain to do well and to avoid those in which they are doomed to fail. (Rose et al., 2012).

The relationship between overconfidence and competition entry has been observed in multiple studies. Researchers have found that gender plays a role in the decision to enter a competition (Niederle and Vesterlund, 2007). When people decide to enter into a competition, researchers have noted that they tend to overweight beliefs about their own performance and underweight beliefs about the performance of their competition, causing them to enter without full consideration of the entire scenario (Moore et al. 2007). Research done on the relationship between overconfidence and entry into competitive markets shows that people tend to enter into competitions they deem "easy" and avoid those they perceive as "difficult" Cain et al. (2015).

The extent to which overconfident individuals enter into competitions can have a significant effect on economic markets. Overconfidence can have severe implications on industry profits and wages. If people are generally overconfident about their relative abilities, then in industries or professions where overconfidence is likely to be largest, industry profits or total wages may be negative (Camerer & Lovallo, 1999). If a person enters an industry as an employee with high optimism in his or her ability, but is unable to supply the high quality of work that they predicted, the firm the person works for loses money. Overconfidence occurs when decision makers, such as traders, investors, managers and financial analysts, are too confident about their ability to make the right decision and give appropriate advice. These overly optimistic estimates of ability can have negative consequences in several domains: People overestimate their own ability to pick stocks, and then trade stocks too often; they take inappropriate risks in product development; they overestimate their chances of winning in court and are therefore too willing to take their lawsuits to trial; and they take excessive risks in founding firms (Moore et al., 2007). Simon and Houghton (2003) find that overconfident

managers overestimate the success of pioneer products, Malmendier and Tate (2008) find that confident CEOs are more prone to take value-destroying merger decisions, and Odean (1999) finds that overconfident investors trade too much.

The goal of the present study is to understand the relationships between overconfidence and entry into competition. It will first aim to show that individuals with low levels of ability, determined by low scores on quantitative reasoning questions, will be more confident in how well they did compared to those who received high scores. Next, it will aim to show the relationship between overconfidence and competition entry by asking participants if they would enter their scores into a competition with Wagner College students and if they want to enter their scores into a competition with Harvard University students, based on how well they perceived they did. To maintain overconfidence, people might self select into "groups" to help sustain this confidence. Because of self selection bias, those who are overconfident are likely to want to remain confident, and therefore likely to choose the "easier" option that will help them do so. It is expected that the proportion of overconfident Wagner students who enter into a competition with other Wagner students is greater than the proportion of overconfident Wagner students who enter into a competition with Harvard students.

Literature Review

The Dunning-Kruger Effect and Overconfidence

Kruger and Dunning (1999) established The Dunning-Kruger Effect across four initial studies. In their second study in particular, the researchers provided 45 Cornell undergraduate students from a single introduction to psychology class with a 20-item logical reasoning test taken from a previous LSAT. After taking this test, participants made three estimates about their

ability and test performance: They compared their "general logical reasoning ability" with that of other students from their psychology class on a percentile scale, they estimated how their score on the test would compare with that of their classmates on a percentile scale and they estimated how many test questions they thought they had answered correctly. The researchers found that participants in the bottom quartile overestimated their logical reasoning ability and test performance to the greatest extent. Individuals scored at the 12th percentile on average, but believed that their general logical reasoning ability fell at the 68th percentile and their score on the test fell at the 62nd percentile. They thought they had answered 14.2 problems correctly on average, but actually had a mean score of 9.6. However, participants in the top quartile underestimated their ability. Individuals scored at the 86th percentile on average, but believed that their general logical reasoning ability fell at the 74th percentile and their score on the test fell at the 68th percentile, a significantly lower percentile.

Pennycook et al. (2017) conducted two studies examining this phenomenon using a cognitive reflection test (CRT), and produced similar results to Kruger and Dunning (1999). This test aims to measure analytic thinking disposition and can include questions such as the following: “A bat and ball cost $1.10 in total. The bat costs $1.00 more than the ball. How much does the ball cost?” A previous study done by these researchers in 2016 determined that around sixty-five percent of people respond with ten cents, despite this being the wrong answer. A possible reason for this occurrence is that people tend to be cognitive misers, or they aim to avoid overusing mental resources in order to conserve energy and rely on solving problems in the most simple and straightforward manner possible, saying the first thing that comes to mind. Pennycook et al. (2017) applied the Dunning-Kruger Effect to this problem, believing that

participants who gave incorrect intuitive responses would fail to recognize their biases. In their first study, participants were given eight CRT items and then asked to estimate the number of questions they had answered correctly. On average, participants estimated that they had correctly solved 5.59 CRT problems but the mean was only 3.88. Additionally, those who scored high on the CRT, receiving a 7 out of 8, estimated that they had scored a 6.36 on average, a statistically significant underestimation of their actual score.

Kruger and Dunning (1999) claim that incompetence stems from a lack of metacognitive skills, or ability to know how well one is performing. One reason incompetent individuals fail to learn that they are unskilled may be because they do not receive enough negative feedback about their abilities from others in everyday life (Kruger & Dunning, 1999). The researchers give an example of the common saying, "If you do not have something nice to say, don't say anything at all," to demonstrate how negative feedback is not commonly welcomed. However, it is not mentioned how competent individuals, who will also experience a lack of negative feedback in their lives, are able to respond to the issue so differently from those who end up being incompetent. The researchers also state that even if individuals do receive negative feedback it is important that they understand why the failure has occurred in order to learn from it, but oftentimes this understanding is limited. In order to be successful, a person must experience several factors: skill, effort, and luck. However, in order to fail, lacking just one of these is enough. It is the inability of individuals to pinpoint why exactly they failed that leads them to attribute their shortcomings not to factors such as skill or effort, but rather to a lack of luck. By doing so, individuals are put under the impression that their failures and any subsequent efforts to correct them, are out of their control.

Kruger and Dunning (1999) studied one particular feedback to which they believe incompetent individuals are unable to respond: social comparison. The incompetent cannot gain insight into their own competence by watching the behavior of others. The researchers gave 84 Cornell undergraduate students a 20-question grammar test then asked them to complete a self-assessment similar to the one given in study one. In the next phase, participants were asked to grade the exams of five other students and evaluate how competent they had been. After grading, participants were asked to reassess themselves. As predicted, participants who scored in the bottom quartile were less able to accurately assess the performance of others than those who scored in the top quartile. These individuals were also unable to gain insight into their own incompetence by observing the behavior of other people. Despite observing high performances by other students, bottom quartile participants did not change assessments of themselves, and some even raised their estimates. On the other hand, top quartile participants raised their self assessment rating after recognizing that other participants had not done as well as them. Kruger and Dunning (1999) attribute their original underestimates to the false-consensus effect. The participants assumed that because they performed so well, their peers must have performed well too. This would lead them to underestimate their comparative abilities. The researchers infer that poor performers provide inaccurate estimates because they are wrong about their own performance, while top performers provide inaccurate estimates because they are wrong about other people. Similarly, Simon and Houghton (2003) suggest that receiving little or ambiguous feedback about prior decisions also increases overconfidence.

Overconfidence and Competition

Overconfidence in one's ability is observed in real life scenarios and can become

problematic when it comes to competition between individuals. For example, Niederle and Vesterlund (2007), conducted a laboratory experiment in which they examined whether men and women of the same ability differ in their selection into a competitive environment. Participants were asked to solve a mathematical task, first under a noncompetitive piece rate and then a competitive tournament incentive scheme. Although they found no gender differences in performance, men selected the tournament twice as much as women when choosing their compensation scheme. The researchers found that men are substantially more overconfident about their relative performance than women and that these beliefs about relative performance help predict entry decisions. Such differences in overconfidence and therefore preferences for competition have economic effects. Holding performance levels between men and women and job characteristics constant, women are less likely to enter into competitions and therefore less likely to win them. Consequently, the chance for women to succeed in competition for promotions or more lucrative jobs decreases.

Cain et al. (2015) further explain the relationship between overconfidence and entry into competitive markets with varying degrees of difficulty within these markets. In this study, participants had to complete two quizzes, one easy and one difficult, which represented making a choice about entering the market with easy or difficult tasks. As they predicted, participants preferred competing on an easy quiz, in which they believed they outperformed others, over a difficult one. The better a person believes they are on a certain task, the higher the chance that they will compete in that task. Therefore, a relationship is developed between task difficulty and competitive market entry. The economic effect of such a concept is that industries thought to be "easy" attract more competitors than difficult ones. If competitors believe that running a business

in a certain industry will be easier than another, then the landscape of that industry will become more competitive. The researchers point out that if there are too few businesses entering into a particular market, prices will rise and the consumers will be the ones who suffer (Cain et al., 2015). However, if there is overentry, businesses will waste resources on fixed costs.

When people compare themselves to others, their judgments tend to be short-sighted. (Moore et al., 2007). Their judgements more closely represent their own abilities with respect to a task, rather than these abilities in relation to others. When a task is relatively easy or all the competitors are strong, each individual competitor tends to believe that he or she will be above average. In other words, people tend to discount the abilities of others and overweight their own. When a task is simple and people predict they will perform well, they expect that their performance will be above average, despite the fact that simple tasks are simple for everybody and not everybody can be above average. When a task is difficult and people expect to perform poorly, they believe that their performance will be below average, despite the fact that difficult tasks are difficult for everybody and not everybody can be below average. Therefore, comparative judgments are often based on short-sighted self-evaluations.

Moore et al. (2007) observed this relationship between overconfidence and entry into competition. In this study, the researchers aimed to examine the market-entry decisions of three groups: actual entrepreneurs, working professionals who considered starting their own firms but did not, and participants in a market-entry experiment. They found that overconfidence played a role in excess market entry, but such confidence was limited to markets in which entrants felt confident about their own personal performance, often ignoring the performance of their competitors. Essentially, they entered markets that they perceived to be “easy,” but avoided those

that seemed "difficult." Some entry decisions may be seen as easy because success in these industries (such as coffee shops, restaurants, or retail) is based in part on knowledge or abilities that most people believe they possess. The researchers noted that entrepreneurs tended to overweight beliefs about their own performance and underweight beliefs about the performance of their competition, causing them to enter a market without full consideration of their surroundings. However, over entry was not observed for all markets. Focusing on oneself increased entry in simple-rank markets, but decreased entry in difficult-rank markets. This means that the tendency to be overconfident in oneself without valuing the success of potential competitors can lead to excess entry in some markets and insufficient entry into others.

A similar result was found by Moore and Cain (2007) who state that people tend to predict that they will be better than others on easy tasks where their own performance is high, but worse than others on difficult tasks where their own performance is low. This is because on skill-based tasks, people have better information about themselves than they do about others, including those who might be competing against them, so their beliefs about others' performances tend to be less extreme than their beliefs about their own performances. Doing well on a task should leave one thinking that they did better than others and doing poorly on a task should leave them thinking that they did worse than others. Moore and Cain (2007) point out that when people use their beliefs about their own performance, they are predicting another person's performance and that is what allows them to decide to enter into competition. However, predictions can only go so far since they are based on one's own beliefs about *themselves* and therefore the ignorance of another's belief. According to Camerer and Lovallo (1999), this is due to reference group neglect. Reference group neglect predicts that when people compete with each

other based on skill, they will not be insufficiently aware of the quality of competition. One implication of this is that people will gather too little data about the nature of their competitors when deciding whether to enter a competition.

Impact on Economic Behavior

Overconfidence is a persistent and prominent behavioral bias found among top executives and has great influence over their firms' financial decisions (Yu, 2014). Firms may often hire overconfident employees for strategic reasons. Overconfident CEOs tend to act more aggressively in research and development to maintain a competitive edge over their rivals. When managers, competing to be appointed CEO, are overconfident, they tend to underestimate project risks and therefore take on more projects than their more realistic counterparts. These managers therefore have a higher probability of being promoted to CEO. While overconfidence may facilitate a firm's economic progress by spurring experimentation, it can lead many individual firms down pathways to disaster and to ultimate failure.

For example, Simon and Houghton (2003) analyze the impact of CEO overconfidence on ill-structured decisions made by managers, such as product introductions. They explain that one important prediction tool that managers use when attempting to forecast the success of their strategies is called a diagnostic cue. Diagnostic cues allow people to retrieve information from previous experiences stored in their memory that will help them predict the extent of success in regards to the scenario at hand (Soll, 1996). They use previous examples of success to make their current predictions. For example, when predicting the success of a new product, a manager may use "positive customer feedback prior to an introduction" as a diagnostic cue that has been frequently associated with the outcome of "achieving positive demand." Overconfidence steps in

when these managers overestimate the extent to which a diagnostic cue can make an accurate prediction. Diagnostic cues are especially poor in predictive validity when the context in which decisions must be made is unfamiliar, such as with a pioneer product, or a product that incorporates a major innovation (Dean, 1969). Its market is therefore ill-defined, since potential and decisions usually have to be made recognizing wide margins of error in terms of cost, demand, and competitor capabilities. In such an instance, the predictive ability of a diagnostic cue breaks down, but a risk averse manager may not recognize this (Simon & Houghton, 2003). Instead, the managers become overconfident because they disproportionately observe instances of the cue's association with positive outcomes, even though they may not pertain to the pioneer product. Therefore, managers responsible for making decisions regarding the product, may overestimate the predictive validity of a cue because they have information about the instances when the cue was associated with a positive outcome and limited information about instances when the cue was associated with a negative outcome, even if the negative outcome was more likely. Therefore, the presence of overconfidence encourages managers to pursue actions that are riskier than those they might have pursued without a biased perception of risk. Simon and Houghton (2003), find that managers taking riskier actions are too certain they will achieve success and thereby underestimate risk.

Malmendier and Tate (2003) analyze the impact of CEO overconfidence on mergers and acquisitions. They looked at Fortune 500 CEOs who held options in their own company’s stock until the year of their expiration. They state that, “Previous literature in corporate finance shows that risk-averse CEOs should exercise stock options well before expiration” (Malmendier and Tate, 2003). By exercising options early, the CEO can diversify his portfolio. But, thet define an

overconfident CEO as someone who will hold an option until its final year, showing that he is consistently optimistic about the company's prospects. The researchers argue that overconfidence can drive the acquirer's, or the company purchasing another company, decision to merge. Mergers and acquisitions are among the most significant and disruptive activities undertaken by large corporations. Overconfident CEOs overestimate their ability to generate returns, both in their current firm and in potential targets. Thus, they undertake mergers their rational counterparts would not. According to Malmendier and Tate's (2003) theory, overconfidence can manifest itself in two ways. On one hand, the manager may overestimate the value of the potential merger. This stems from the manager's belief that his leadership skills are "better than average," and thereby better than the target's current management, or from an underestimation of the downside to the merger due to the "illusion of control" over its outcome. Because the CEO conducting the merger is essentially replacing the current management of the target firm with himself, he is likely to feel an illusion of control over the outcome and to underestimate the likelihood of failure. On the other hand, the manager may overestimate the value of his current company or that his company's worth is undervalued by the market. Malmendier and Tate (2003) find that not only are overconfident CEOs more likely to conduct mergers on average, but they

are also more likely to conduct bad mergers, or mergers that either have no value or destroy value for the acquiring firm's shareholders.

Overconfidence is also an issue in investment and trading. Odean (1999) proposed that due to their overconfidence, investors will trade too much. People who are more overconfident in their investment abilities may be more likely to seek jobs as traders. This would result in an

increase of overconfident individuals in the population of investors. Consequently, traders who find further success in their investments successful in the past may overestimate the degree to which they are responsible for their own successes and grow increasingly overconfident. Odean (1999) found that when trading is costly, rational investors will not make trades if the expected returns from trading are insufficient to offset costs. Overconfident investors, however, have unrealistic beliefs about their expected trading profits. They may engage in costly trading, even when their expected trading profits are insufficient to offset the costs of trading, mainly because they overestimate the magnitude of expected profits. Overconfident investors often believe that they have useful information, when in fact they have no information.

Cooper et al. (1988) collected data from 2994 entrepreneurs who had recently become business owners and analyzed it to determine their perceived chances of success. They perceived their prospects as very favorable. Out of almost 3,000 entrepreneurs, 81% believed that their chance of success was 70% or higher; and a massive 33% estimated their chance of success to be 100%.

In the world of business and finance, such overconfidence can lead to erroneous decisions with serious financial consequences. Moosa and Ramiah (2017), state that it is not implausible to suggest that overconfidence has been a reason for corporate collapses and recurring financial crises where decision makers put too much faith in their predictions. They give an example of the collapse of the hedge fund LTCM (Long-Term Capital Management) in 1998 and the insurance giant AIG (American International Group) in 2008. These events were the results of blind beliefs in models predicting that something would never happen, which then ended up happening. The LTCM model was devised by Nobel Prize winners who were known to be good

at solving partial differential equations. It predicted that bond yields could not deviate significantly, but this was not the case. LTCM's capital fell from $4.8 billion at the beginning of 1998 to only $600 million in September. Its investors lost 88 percent of their investment (Stonham, 1999). The AIG copula-based model (a multivariate distribution whose marginal distributions are uniformly distributed on the interval (0,1) (Kolev & Paiva, 2009)), constructed by statisticians, predicted that house prices in the United States could not fall nationwide, leading to overselling of credit default swaps, without adequate financial cover. Terzi and Uluçay (2011) define credit default swaps as privately negotiated bilateral contracts in which one party, the buyer, pays a fee or premium to the other party, the seller, to protect himself against the loss that may be acquired due to exposure to an individual loan or bond as a result of an unforeseen event. AIG, with $1 trillion in assets, lost $99.3 billion during 2008 (McDonald & Paulson, 2015). Policy makers, who put too much trust into their models and believed too much in the ability of the market to correct itself, were false in their predictions, which led to the collapse of their firms (Moosa & Ramiah, 2017).

The current study will show that individuals with low levels of ability, determined by low scores on a mathematical series questionnaire (Appendix B), will be more confident in how well they did compared to those who received high scores. These individuals are expected to rank themselves higher when comparing how they think they scored on the questionnaire to other college students, estimate that they received a higher score on the questionnaire than they actually did, and to find the questionnaire less difficult than participants who are not overconfident. The relationship between overconfidence and competition entry will be observed by asking Wagner College participants if they want to enter their scores into a competition with

other Wagner students and if they want to enter their scores into a competition with Harvard students. It is hypothesized that the proportion of overconfident Wagner students who enter into a competition with other Wagner students is greater than the proportion of overconfident Wagner students who enter into a competition with Harvard students. In other words, overconfident participants will be more likely to enter a competition with other Wagner students.

Considerations of previous literature by Moore et al. (2007) and Cain et al. (2015) led to the assumption that overconfident participants will be more likely to enter a competition with other Wagner students rather than Harvard students. At first, it may seem as though overconfident individuals should be expected to enter into competitions with both Wagner and Harvard students. The very definition of overconfidence should suggest that these individuals are confident in their abilities and should be willing to enter into any competition. However, these researchers have shown that although they have high levels of confidence in their abilities, individuals do not prefer to enter into competitions pertaining to difficult tasks. It is possible that they want to maintain their high levels of confidence by self selecting into easier options, which will help them remain overconfident. In the current study, participants are tasked with entering into a tournament, or a “winner takes all" situation. Here, only the winner will be rewarded and the loser will get nothing, therefore participants should be self-assured that their scores will be strong enough to win. In this study, the degree of difficulty of the questions *does not* change. Rather, the perceived difficulty of the competition itself changes. The options to enter into competition with students from Wagner, a small liberal arts school with an acceptance rate of 70% (The Princeton Review, Wagner College) and students from Harvard, an ivy-league school with an acceptance rate of 5%, (The Princeton Review, Harvard College) represent these changes

in difficulty. Harvard was chosen as an option because of the stereotype that students there are exceptionally smart. Though these questions are rather subjective, it is interesting to observe whether this stereotype and the name "Harvard" will have an effect on competition entry.

One aspect of the study will examine the Dunning-Kruger effect by measuring overconfidence among participants. The second aspect will examine if a higher frequency of overconfident individuals choose to compete with Wagner students compared to Harvard students.

Method

Participants

Participants were 30 Wagner College students who received access to a Qualtrics questionnaire link via social media and messaging. Ages of the participants ranged from 18 to 22 years old, ethnicity was mainly white, but included one of each of the following: African American, Hispanic, and mixed. Out of the participants 3 were male and 27 were female. Participants did not receive any benefits, such as money or class credits, all participation was strictly voluntary.

Materials and Procedures

After filling out an informed consent form (Appendix A), participants were asked to fill out a questionnaire containing 5 mathematical reasoning questions (Appendix B) taken from a math practice website (Number Series Questions and Answers, 2005). These questions required participants to have strong quantitative reasoning abilities. After answering these questions, participants were given 5 self-assessment questions asking them how difficult from 1 to 10 they thought the questionnaire was, to compare how they think they scored on this questionnaire to

other college students based on percentile rank, and to note how many questions out of 10 they think they answered correctly. The last two questions asked participants: if you were told that in a tournament, the student with the greater score would win $10, would you enter your answers into this tournament with another Wagner College student? Would you enter your answers into this tournament with a Harvard University student? Participants were not given a timeframe to complete the questionnaire. A debriefing statement (Appendix C) and scores to the questionnaire were provided at the end of the survey.

A within-subject design was used in this study, exposing all participants to both tournament conditions. Each participant was asked whether they would like to enter the scores into either tournament, one with Wagner students and one with Harvard students. However, between-subjects would likely have been a cleaner experimental design, as explained in the discussion.

By using math series questions, the study aims to challenge the participants' quantitative reasoning ability. Quantitative reasoning is the application of basic mathematics and statistics skills, interpret data, draw conclusions, and solve problems (Elrod, 2014). It requires critical thinking and problem solving. While the questions used in this study (Appendix B) may appear inconsequential and tedious, the ability to interpret quantitative information is not only relevant, but critical in the analysis and interpretation of data in real world scenarios.

Examples of quantitative reasoning can be found in areas such as health, economics, politics, science, engineering, social science, and even the arts. For example, parents face the vaccination question early in the life of their children. Parents might ask questions like, "What are the risks associated with vaccinating my child and what are the benefits?" In order to answer

these questions, they must take into account quantitative information, such as disease occurrence rates in populations over time, or numbers of cases of complications with certain vaccine preparations (Elrod, 2014). In economics, quantitative reasoning can be applied in understanding the power of compound interest or the uses of percentages and in research, it can be applied to analyze accuracy of a statistical study.

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Results

Overconfidence

To first demonstrate that participants were overconfident in their abilities on the questionnaire, a series of regressions were performed. The tests analyzed the relationship between overconfidence and three different variables: estimated percentile rank compared to other students, estimated score out of 10 questions, and actual score. Overconfidence was operationally defined as the estimated score divided by the actual score participants received on the questionnaire. If this number was greater than zero, the participants were said to have overestimated their scores. If this number was zero or less than zero, the participants were said not to have overestimated their scores. Five participants overestimated their performance by at least one question and 25 participants did not overestimate.

As anticipated, participants identified as overconfident (M = 67.00, SD =8.36) rated themselves as doing better on the questionnaire than other students in contrast to participants who were not overconfident (M = 57.44, SD = 24.22) (Figure 1). The regression, rank = $\beta_0 + \beta_1$ overconfidence + ε, was run and the following equation was established: rank = 34.53 + 28.15 overconfidence. Using the T- Distribution table and 29 degrees of freedom, the critical t value

(t_c) is found to be 2.045 at a 5% level of significance. The t-statistic for overconfidence, t = 3.09, is greater than t_c indicating that a statistically significant relationship exists between overconfidence and the percentile rank that participants predicted. The p value from the F-test also suggests that the regression is valid, Prob > F = 0.0044.

Similarly, participants identified as overconfident (*M* = 5.40, *SD* = 0.89) predicted receiving higher scores in contrast to participants who were not overconfident (*M* = 4.84, *SD* = 2.03) (Figure 2). The regression, guess = $\beta_0 + \beta_1$ overconfidence + ε, was run and the following equation was established: guess = 2.47 + 2.83 overconfidence. The t-statistic for overconfidence, t = 4.02, is greater than t_c = 2.045 at a 5% level of significance, indicating that a statistically significant relationship exists between overconfidence and participants' estimated score. The p value from the F-test also suggests that the regression is valid, Prob > F = 0.0004.

Also as expected, participants identified as overconfident (*M* = 3.60, *SD* = 0.89) received lower scores in contrast to participants who were not overconfident (*M* = 6.28, *SD* = 1.62) (Figure 3). The regression, score = $\beta_0 + \beta_1$ overconfidence + ε, was run and the following equation was established: score = 6.63 - 0.91 overconfidence. However, the absolute value of the t-statistic for overconfidence, t = 1.09, is not greater than t_c = 2.045 at a 5% level of significance, indicating that a statistically significant relationship does not exist between overconfidence and participants' scores. This is also suggested by the p value from the F-test, Prob > F = 0.2843.

Additionally, a regression was run to identify the relationship between overconfidence and the perceived difficulty of the math series questions. Participants identified as overconfident (*M* = 4.40, *SD* = 1.34) found the questions to be less difficult in contrast to participants who were

not overconfident (*M* = 7.36, *SD* = 1.86) (Figure 4). The regression, difficult = $\beta_0 + \beta_1$ overconfidence + ε, was run and the following equation was established: difficult = 10.04 - 3.65 overconfidence. The absolute value of the t-statistic for overconfidence, t = -5.23, is greater than $t_c = 2.045$ at a 5% level of significance, indicating that a statistically significant relationship exists between overconfidence and perceived difficulty of the questions. The p value from the F-test also suggests that the regression is valid, Prob > F = 0.0000.

Competition Entry

After establishing the presence of overconfident participants, three subequations were established to determine the relationship between overconfidence and the participants' decision to enter into a competition with Wagner or Harvard students. A third equation was included to observe the relationship between overconfidence and the participants' decision to enter into a competition with students from both schools. The equations used to model these relationships are:

$$\text{Wagner} = \beta_0 + \beta_1 \text{ overconfidence} + \varepsilon$$

$$\text{Harvard} = \beta_0 + \beta_1 \text{ overconfidence} + \varepsilon$$

$$\text{Both} = \beta_0 + \beta_1 \text{ overconfidence} + \varepsilon$$

After running the regressions, the following equations and t-statistics were established: Wagner = 0.70 - 0.002 overconfidence, where $t_{Wagner} = -0.01$; Harvard = 0.48 - 0.02 overconfidence where $t_{Harvard} = -0.07$; Both = 0.43 + 0.01 overconfidence, where $t_{Both} = 0.04$. However, no absolute values of the t-statistic for overconfidence were greater than $t_c = 2.045$ at a 5% level of significance, indicating that the coefficient, or marginal effect, is not statistically significantly different from zero for the decision to enter into a competition with Wagner

students, Harvard students, or both. Therefore, the null hypothesis that the proportion of overconfident Wagner students who enter into a competition with other Wagner students is not greater than the proportion of overconfident Wagner students who enter into a competition with Harvard students, cannot be rejected.

Lastly, a proportion test was run to determine what proportion of strictly overconfident participants chose to compete against Wagner College students and what proportion chose to compete against Harvard University students. A greater proportion of overconfident participants chose to enter into a competition with other Wagner students ($M = 0.60$, $SD = 0.22$) than they did with Harvard students ($M = 0.40$, $SD = 0.22$) (Figure 5). However, by evaluating the p value of the z-test, $P > |z| = 0.527$, it is evident again that there is no statistically significant difference between the proportion of participants who chose to compete with Wagner students and the proportion of participants who chose to compete with Harvard students.

Discussion

These results show that several participants could be identified as overconfident in their ability to perform well on this quantitative reasoning questionnaire. The results also demonstrate a statistically significant relationship between overconfidence and three other variables: percentile rank, estimated score, and perceived difficulty. As the number indicating how well participants think they did on the questionnaire based on percentile rank increased, so did levels of overconfidence. Similarly, as the number of questions participants believed they got correct increased, overconfidence increased. As perceived difficulty of the questionnaire increased, the level of overconfidence actually decreased. As explained by the Dunning Kruger effect, overconfident individuals have high levels of certainty that their abilities are strong, even though

this confidence is unfounded. Because these individuals are confident in their abilities, they don't find this questionnaire as difficult as their non-overconfident counterparts. The observed relationship between overconfidence and scores was also supported by the Dunning Kruger effect, as it showed that overconfident participants received lower scores on the questionnaire than those who were not overconfident. However, these results were not statistically significant and it cannot be ruled out that this relationship occurred by chance.

These results cannot support the hypothesis that a greater proportion of overconfident participants will enter into a competition with other Wagner College students than the proportion of overconfident participants who enter into a competition with Harvard students. Though the observed proportion of participants entering into a competition with Wagner students was greater than those entering into a competition with Harvard students, these results were not statistically significant and again, it cannot be ruled out that this relationship occurred by chance.

There were several limitations associated with this study. One such limitation is the small number of participants in the study. Had there been a larger sample size, the data would have likely been more accurate and representative of the population of Wagner College students. A larger sample size would allow for more accurate mean values and a smaller margin of error. Only 5 participants were identified as overconfident, making the chance of accurately identifying the proportion of overconfident participants entering into a competition very low. Had the sample size been larger, more overconfident participants would have been recognized, which would have allowed for a far more accurate regression and proportion test, possibly with statistical significance.

Another limitation of this study was the use of a within-subjects design, rather than a between-subjects design. In between-subjects, participants would have been assigned to two different conditions, with each participant experiencing only one of the tournament conditions. Half of the participants could have been asked whether they would like to enter into a tournament with Wagner students and the other half could have been asked if they would like to enter into a tournament with Harvard students. Using this design could provide more confidence that the differences between the groups, those exposed to Wagner and those exposed to Harvard, are due to the differing treatments rather than to other treatment factors, such as order effects, that can occur when the same individual is exposed to more than one treatment. Order effects occur when participants are exposed to the same treatment conditions, in the same order. This is especially prominent in within-subject designs. In this study, displaying the same questions regarding Wagner students and Harvard students, particularly in the same order, could have made order effects more pronounced. Respondents could have reacted differently to the questions based on the order in which the questions appeared. Seeing the 'Wagner question' first, could have affected the way they answered the 'Harvard question.'

Another limitation of the study was the subjective nature of the Wagner and Harvard options. It was thought that participants would assume entering into a competition with Harvard students would be more challenging simply based on stereotypes. However, it cannot be expected that all participants feel the same way about Harvard students' levels of intelligence compared to students at Wagner. Because of within-subjects design, it is possible that participants may have actually been looking at these options as substitutes. Rather than observing

two distinct options, participants may have felt as though they had to have chosen to compete against Wagner students *or* Harvard students.

Despite its limitations, this study adds to the understanding of the relationship between overconfidence, as explained by the Dunning Kruger effect, and entry into competition. Although the hypothesis that the proportion of overconfident Wagner students who enter into a competition with other Wagner students is greater than the proportion of overconfident Wagner students who enter into a competition with Harvard students could not be accepted, the research provides a basis for future studies. If the study were to be conducted again it is recommended that a between-subjects design and a larger sample size be used so more tests can be run on strictly overconfident individuals.

Conclusion

The impact of overconfidence on economic behavior is explained by Simon and Houghton (2003), Malmendier and Tate (2003), and Odean (1999). Managerial overconfidence regarding decisions about product introductions, mergers and acquisitions, and trading can lead severe financial consequences for firms. Moosa and Ramiah (2017) demonstrate how overconfidence likely led to the collapse of two firms which resulted in severe financial financial crises. Overconfidence and misguided predictions clearly play a significant role in business, finance, and simply in everyday life.

However, Kruger and Dunning (1999) explain that overconfidence can be unlearned with an improvement in metacognitive skills. When Kruger and Dunning (1999) gave participants a training session to improve logical reasoning skills before being asked to make self assessments, they made much more accurate judgements. After being given a training packet, participants who

were originally in the bottom quartile were just as accurate in monitoring their test performance as those in the top quartile. Ehrlinger et al. (2016) state that one effective strategy for improving accuracy in self assessments is to shift people's attention toward more difficult aspects of a task, which can inspire more accurate self evaluations among people who demonstrate the most overconfidence. This agrees with research conducted by Moore et al. (2007) and Cain et al. (2015). After conducting a study to determine initial levels of confidence, the researchers manipulated their participants' attention towards easier or more difficult problems on a general knowledge quiz. When attention was placed on easier problems, participants with entity views of intelligence (a belief that intelligence is fixed) showed greater overconfidence in their abilities than participants with incremental views of intelligence (a belief that intelligence can be improved). However, when attention was placed on more difficult problems, confidence fell to the same level for both types of participants, showing that this intervention might help discourage overconfidence and inspire greater self-insight.

Beliefs about one's abilities are incredibly important when it comes to decision making. But in order for beliefs to be helpful in making unbiased and careful decisions, a person must not be overconfident. A person must not overestimate their abilities, especially when these abilities are not realistic. Such overconfidence plays a huge role in decisions to enter into competitions, decisions people have to make in their everyday life. If people are not careful, their misinformed beliefs can lead to negative consequences.

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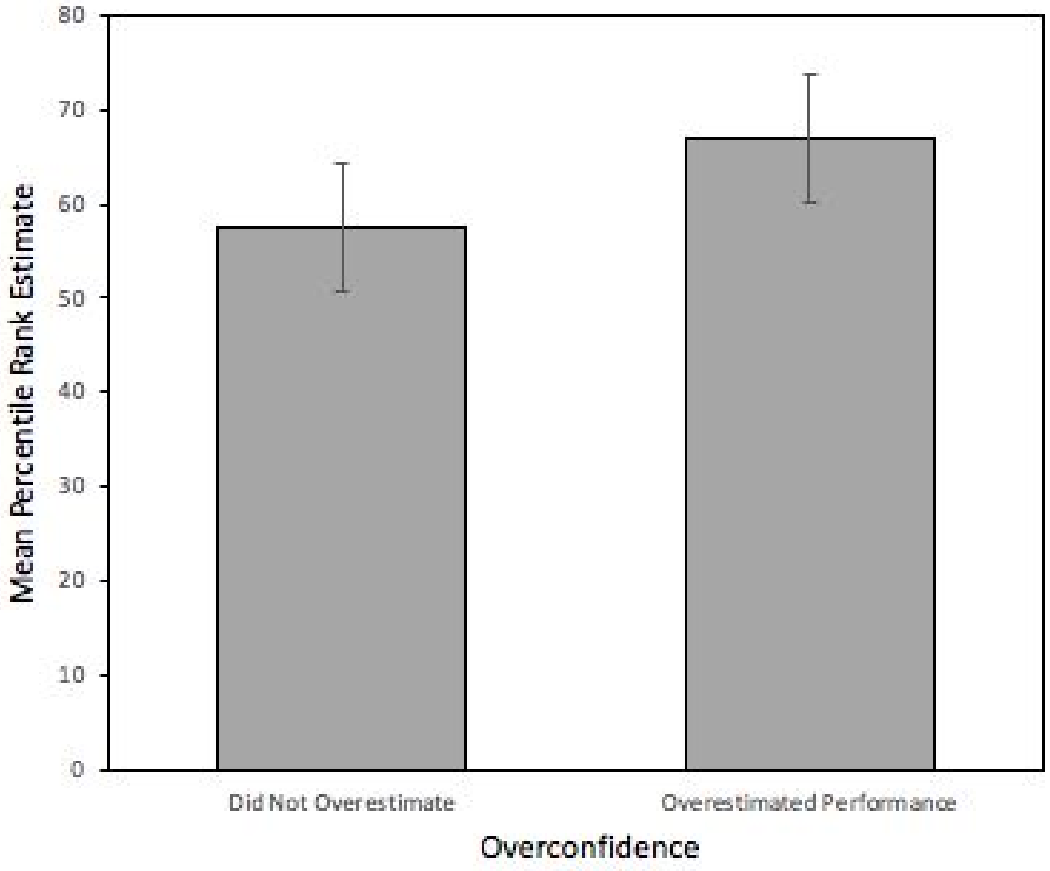

Figure 1. Participants identified as overconfident significantly overestimated how well they did, in terms of percentile rank, on the questionnaire than other students in contrast to participants ability in contrast to participants who were not overconfident.

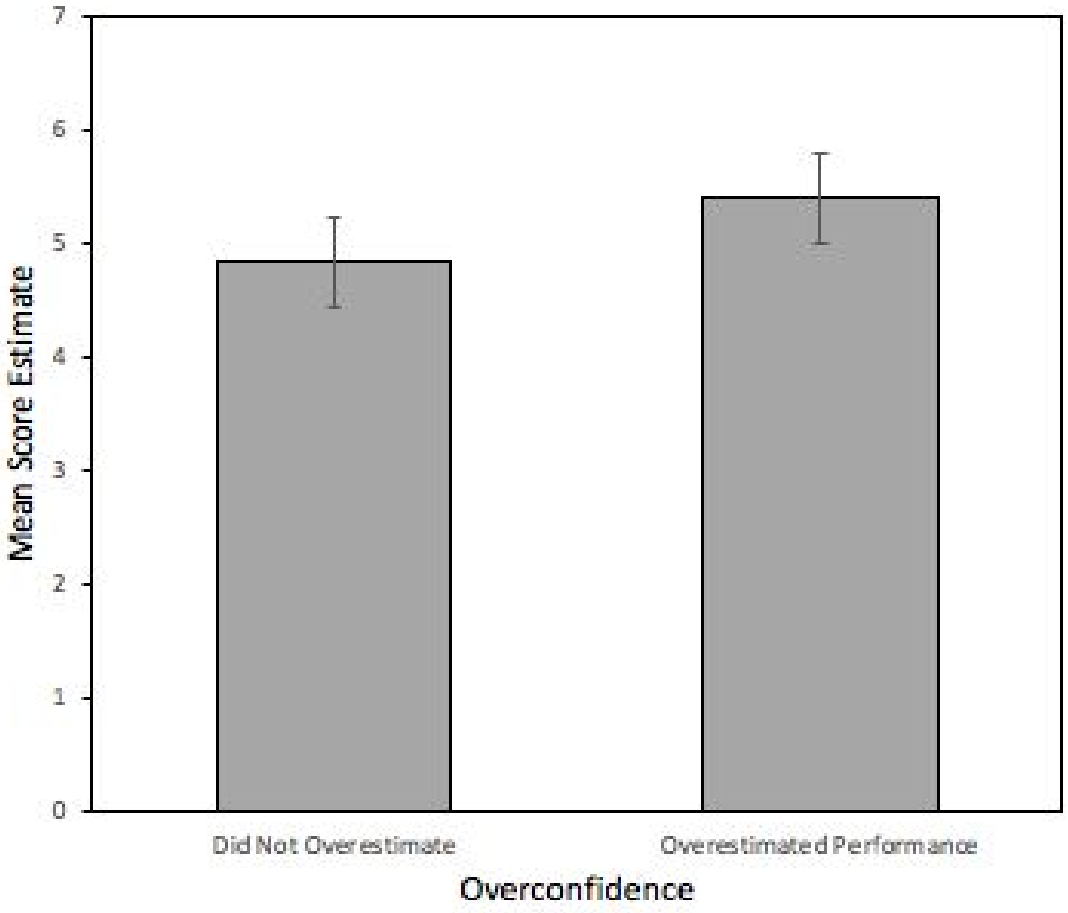

Figure 2. Participants identified as overconfident significantly overestimated their scores on the questionnaire in contrast to participants who were not overconfident.

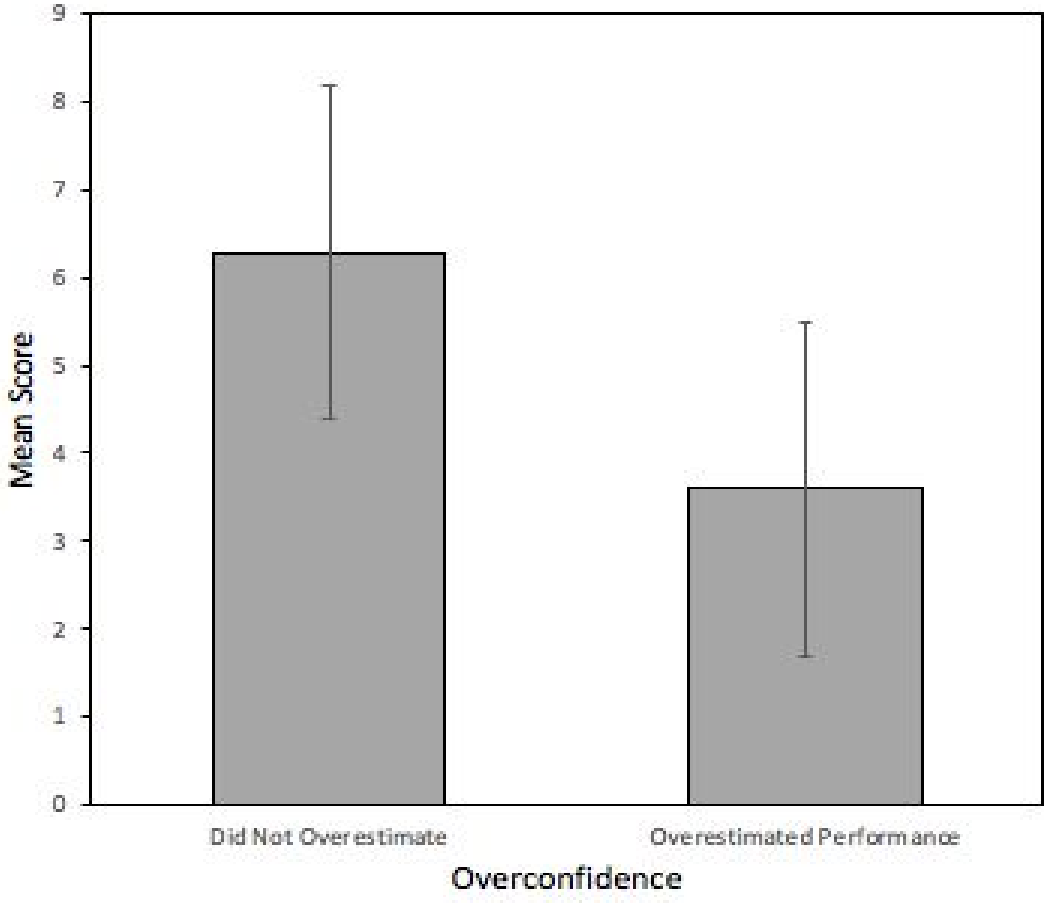

Figure 3. Participants identified as overconfident saw lower scores in contrast to participants who were not overconfident. However, this difference was not statistically significant.

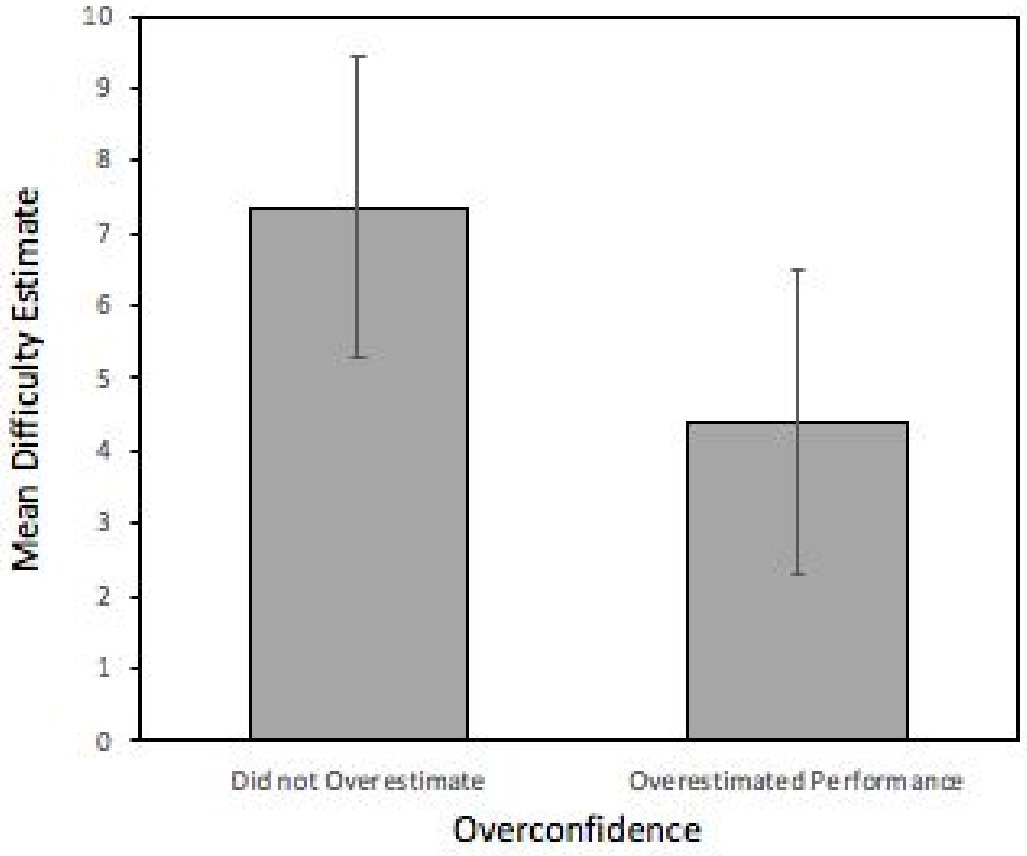

Figure 4. Participants identified as overconfident found the questions to be significantly less difficult than participants who were not overconfident.

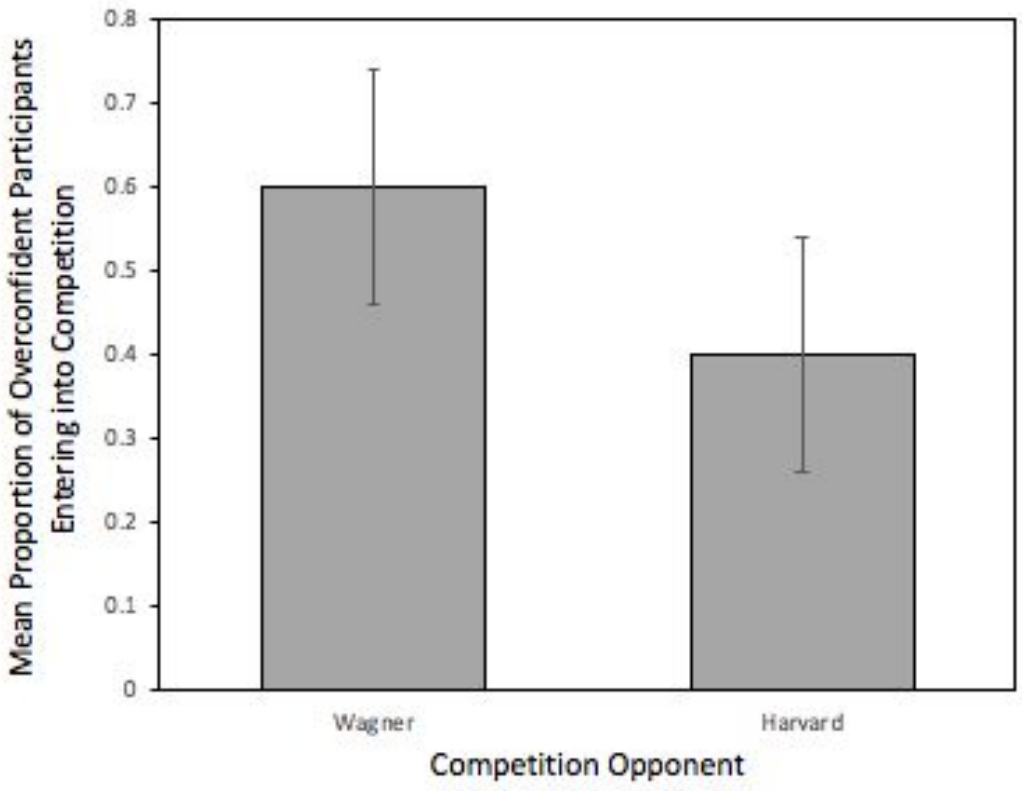

Figure 5. A greater proportion of overconfident participants chose to enter into a competition with other Wagner students than they did with Harvard students. However, this difference was not statistically significant.

Appendix A

Informed Consent Form

The Department of Psychology at Wagner College supports the practice of protection of human participants in research. The following information is provided for you to decide whether you wish to participate in the present study. You should be aware that even if you agree to participate, you are free to withdraw at any time.

In this study you will be asked to complete a questionnaire. You will be asked to report your answers 3 demographic questions, 10 math series questions, and 5 self assessment questions. Immediately following your participation today, you will be provided with more detailed information regarding the purpose of this study. Although participation will not directly benefit you, it is believed that information you provide will be useful in furthering our understanding of perceptions and attitudes.

Your participation is solicited although strictly voluntary. Although this questionnaire will request some demographic information about you, your responses will be kept completely confidential. If you would like additional information concerning this study before or after it is completed, please feel free to contact me by email.

Sincerely,

Debra Shteinberg

Debra.Shteinberg@wagner.edu

Do you consent to these terms?

(1) Yes

(2) No

Appendix B

Knowledge of Quantitative Reasoning Questionnaire

Demographics

1. What is your age?

   _____

2. What is your gender identity?

   _____

3. What is your ethnicity?

   _____

Mathematical Series Questions

1. Look at this series: 42, 40, 38, 35, 33, 31, 28 ... What numbers should come next?

   (1) 25, 22

   (2) 26, 23

   (3) 26, 24

   (4) 25, 23

   (5) 26, 22

2. Look at this series: 3, 5, 35, 10, 12, 35, 17 ... What numbers should come next?

   (1) 22, 35

   (2) 35, 19

   (3) 19, 35

   (4) 19, 24

   (5) 22, 24

3. Look at this series: 544, 509, 474, 439 ... What number should come next?

(1) 404

(2) 414

(3) 420

(4) 445

4. Look at this series: 2, 3, 4, 5, 6, 4, 8 ... What numbers should come next?

(1) 9, 10

(2) 4, 8

(3) 10, 4

(4) 9, 4

(5) 8, 9

5. Look at this series: 28, 25, 5, 21, 18, 5, 14 ... What numbers should come next?

(1) 11, 5

(2) 10, 7

(3) 11, 8

(4) 5, 10

(5) 10, 5

6. Look at this series: 5, 16, 49, 104 ... What number should come next?

(1) 171

(2) 191

(3) 181

(4) 161

7. Look at this series: 664, 332, 340, 170, ____, 89, ... What number should fill the blank?

(1) 85

(2) 97

(3) 109

(4) 178

8. Look at this series: 5, 8, 28, 162, ____, 12870 ... What number should fill the blank?

(1) 1738

(2) 2318

(3) 1288

(4) 2224

(5) 2950

9. Look at this series: 16, 41, 61, 85, ____, 145... What number should fill the blank?

(1) 124

(2) 167

(3) 119

(4) 113

(5) 185

10. Look at this series: 16, 43, 98, 209, ____, 879... What number should fill the blank?

(1) 428

(2) 432

(3) 386

(4) 422

(5) 396

Self Assessment

1. How difficult did you find this questionnaire? (On a scale from 1 to 10)

0 1 2 3 4 5 6 7 8 9 10

Not at all difficult Extremely difficult

2. Compare how you think you scored on this questionnaire to other students based on percentile rank. (Rank from 1-99)

Note: For example, if you say you are in the 75th percentile this means you scored as well or better than 75% of students.

Percentile Rank:

_____

3. How many questions out of 10 do you think you got correct?

_____/10

4. If you were told that in a competition, the student with the greater score would win $10, would you enter your answers into a competition with another Wagner College student?

Note: This is a hypothetical scenario.

(1) Yes

(2) No

5. If you were told that in a competition, the student with the greater score would win $10, would you enter your answers into a competition with a Harvard University student?

Note: This is a hypothetical scenario.

(1) Yes

(2) No

Appendix C

Debriefing Statement

Thank you for participating in this study!

As a reminder, all of your results will be kept confidential.

This study examines the relationship between knowledge of quantitative analysis, overconfidence in this knowledge, and the decision to enter into a competition regarding this subject area.

Each participant was given a questionnaire that contained 10 mathematical series questions found online.

Based on my review of previous research, I am interested in determining if individuals with lower levels of proficiency (lower scores on the questionnaire) will overestimate their ability and performance in this subject area and subsequently enter into competition more often.

Previous studies have confirmed this hypothesis and the phenomenon has been called the Dunning-Kruger Effect.

If you have any questions or would like a copy of the final research report, please feel free to contact me.

Contact Information:
Debra Shteinberg - Researcher
Debra.Shteinberg@wagner.edu