

The effects of verbal instruction, age, and gender on performance and self-efficacy during cognitive tasks in high school students

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BRIEF. This study examines the relationship between verbal instruction and self-efficacy, as well as investigating the role of age and gender as predictors of self-efficacy.

ABSTRACT. Self-efficacy refers to the belief that an individual has in their ability to complete a task and is important because it has been shown to influence both an individual's effort and performance on that task. Generally, one major source of self-efficacy is verbal persuasion, or encouragement and discouragement relating to an individual's performance. The present study aimed to gauge the effects of verbal persuasion, age, and gender on self-efficacy and performance during cognitive tasks in high school students. Twenty-three participants were recruited and divided into three different groups: positive persuasion, negative persuasion, and no persuasion. Individuals completed two cognitive tasks, a Memory Task and a Directional Task, and were assessed on their performance and self-efficacy relating to these tasks. Results indicated that while persuasion had no significant direct effect on self-efficacy or performance specifically related to cognitive tasks, females experienced significantly less self-efficacy as age increased when compared to males ($p < 0.05$). Additionally, no correlation was found between Memory Task and Directional Task self-efficacy, which could be explained by the high domain-specificity of self-efficacy. Based on these results, special support should be granted by teacher or mentors to females with low self-efficacy.

INTRODUCTION.

Encouragement and discouragement are ubiquitous in every-day life, whether that be through a morale-boosting remark from a parent or friend or a disheartening grade on a project. Though one may feel that they can easily shrug these comments or feelings off, both encouragement and discouragement have been shown to have major effects on an individual's self-efficacy, or the belief that an individual has in their ability to achieve a task [1]. Self-efficacy is important to an individual's success because it can influence the amount of effort an individual may put forth towards a task or even an individual's performance in many areas, including academics and sports [2-5]. Furthermore, self-efficacy is crucial in the context of high school, as it is positively correlated with engagement in school, discouraging problems such as school dropout, criminal activity, depression, and anxiety [16], [17]. However, most research concerning high school students has focused on studying self-efficacy related to academic subjects rather than broader cognitive functions such as short-term memory; of those, few, if any have directly studied the effects of verbal persuasion.

Self-efficacy is impacted mainly by mastery experiences (previous incidents of success or failure), vicarious experiences (the performance of other respected figures or models), verbal persuasion (encouragement or discouragement regarding an individual's performance), and emotional arousal (feelings of anxiety or worry relating to the task at hand) [6-9]. Though all four sources of self-efficacy are important for understanding the topic as a whole, this study will focus primarily on the verbal persuasion aspect.

While verbal persuasion does have a connection to self-efficacy, research provides differing results regarding the relationship between verbal persuasion and self-efficacy. Some studies suggest a direct relationship between verbal persuasion. In topics such as parenting and science, results have shown that those who receive negative persuasion report lower self-efficacy than those who receive positive verbal persuasion [10], [11]. Other studies show that the effect of verbal persuasion on self-efficacy lies mainly in its interaction with mastery experiences. In math, two studies noted that verbal persuasion had no independent contribution to self-efficacy but proposed that verbal persuasion could have the ability to shape what a mastery experience means for an individual [13], [14].

Additional factors can affect self-efficacy. Age plays a critical role in self-efficacy, with self-efficacy increasing as age increases [15]. Gender also affects self-efficacy. For example, female students typically have higher greater self-efficacy than males in subjects such as writing [12], but lower self-efficacy than males in general academics, business, and entrepreneurship [18], [19]. One possible explanation for these differences is that self-efficacy has been found to have high domain-specificity, meaning that a measure of self-efficacy for a single topic often cannot be generalized across other domains [15].

Based on previous research and its limitations, the aims of this study will be to investigate the effects of age, gender, and persuasion on cognitive performance and self-efficacy, as opposed to self-efficacy pertaining to specific academic subjects such as math or reading. The specific cognitive skills gauged in this study include short term memory and complex direction following. The first hypothesis (H1) is that positive verbal persuasion will increase self-efficacy; similarly, negative verbal persuasion will decrease self-efficacy. It is also hypothesized that positive verbal persuasion will improve performance on cognitive tasks, while negative verbal persuasion will impair performance (H2) [20]. Furthermore, it is predicted that self-efficacy will increase with age (H3) [15], and that there will be no significant gender difference on self-efficacy (H4).

MATERIALS AND METHODS.

Participant recruitment.

A total of 23 students (7 male, 16 female; 35% White, 30% Asian, 17% Black or African American, 13% Hispanic or Latino, and 4% Middle Eastern) participated in this study. Although consent was obtained from 31 individuals, 8 did not fully complete the study and were excluded from further data analysis. Subjects ranged from 13 to 18 years old ($M: 16.17 \pm 1.4$) and were recruited from the School for Science and Math at Vanderbilt and high schools in urban Nashville. Prior to study participation, parental consent and minor assent was obtained via REDCap. After giving consent, each participant was sent a unique Study ID number that was not associated with their email address and could not be linked back to their survey responses. Each student was also randomly assigned to one of three groups: A, B, or C. Students in Group A received positive verbal instruction throughout the study, Group B received negative verbal instruction, and Group C

acted as control, receiving no verbal persuasion. Additionally, each participant was instructed to complete a participant demographic form, which collected information including the gender, ethnicity, and age. In order to administer the experiment virtually, each participant was sent a link to a YouTube video to guide the participant through the procedure.

The Directional Task.

The first cognitive ability measured in this study was the ability to follow complex directions. Participants completed a complicated puzzle in four minutes that required careful reading of a set of instructions. Each group received the exact same puzzle and instructions but differed in the verbal persuasion received. Before attempting the puzzle, groups A and B received positive and negative persuasion respectively based upon Newlin, located as background information at the top of the page before the puzzle and its instructions [21]. Group A received positive persuasion stating that “high school students are reliable and accurate when completing directional tasks,” while Group B received negative persuasion such as “high school students are not reliable and accurate when completing directional tasks.” Group C received no persuasive information. Afterwards, participants filled out a survey to judge their performance on the directional task and their self-efficacy regarding the task. Self-efficacy was judged using a scale from 1 to 5, with 1 representing “strongly disagree” and 5 representing “strongly agree.”

The Memory Task.

After completing the Directional Task, the participant then completed the Memory Task, which was made up of two separate parts, a series of questions pertaining to a short story and a digit-span test. In order to administer the verbal persuasion, a participant in either group A or B was read a short story and then answered a set of questions from memory pertaining to the story [22]. The questions and story slightly varied depending on the group, with Group A receiving an easier story and questions than Group B. Whether or not the participant answered all the questions correctly, they received a set of different persuasions based on their group, which appeared as a line of text after the participant submitted their survey, based upon Cassé [10]. For example, Group A was told: “Congratulations! Your score on the memory test was above the average number of correct responses. You are more capable of remembering information over a short amount of time than most participants. This is an important skill and will be useful in the next task.” Group B was told: “Unfortunately, your score on the memory test was below the average number of correct responses. You are less capable of remembering information over a short amount of time than most participants. That is unfortunate considering that the next task will draw on this important skill.” Group C, the control group, did not take part in this task but moved directly to the digit-span task.

Afterwards, all groups took part in an online digit-span test, which is commonly used to evaluate attention capacity and working memory [23]. During this test, a series of digits was displayed and read to the participant. The participant then immediately repeated the sequence of digits, after which they would be presented another sequence of digits, increased by one digit. Two variations of the test were administered: one where the participant repeated the digits forwards, and one where the digits were repeated in the opposite order. Each participant attempted both tests once, and the tests were discontinued if the participant repeated the numbers incorrectly. The participant’s score on this task corresponded to the sum of the maximum number of digits they repeated correctly for both the forward and backward variations [24], [25]. Another survey based upon the Memory Self-Efficacy Questionnaire was administered to measure performance and self-efficacy on

the Memory Task, using a Likert scale of 1 to 5 [26], with 1 representing “strongly disagree” and 5 representing “strongly agree,” with the scale identical to the Directional Task.

After completing the survey corresponding to the Memory Task, each participant was debriefed and thanked for their time.

RESULTS.

Coefficient alphas of reliability for the Directional Task and Memory Task were 0.66 and 0.77 respectively, indicating that the Likert scale surveys were reliable. To determine a singular value for both complex directional-following and memory self-efficacy, efficacy scores were summed across the questions then divided by the number of questions. The score for performance on the Directional Task was listed as the number of questions correct out of three, while the performance on the digit-span test was calculated by adding together the scores for both the forward and backward variants. Using Levene and Bartlett tests, it was found that the data did not violate the assumption of homogeneity of variance, meaning that the data did not depart from normal variances and that ANOVA tests could be used for further analysis. A multivariate analysis relating all continuous variables is listed in Table 1.

Table 1. Descriptive statistics and correlations for study variables

Variable	<i>M</i>	<i>SD</i>	1	2	3	4	5
1. Age	16.17	1.40	—				
2. Directional Task Self-Efficacy	3.83	0.80	-0.13	—			
3. Directional Task Time	3.43	0.79	-0.19	0.07	—		
4. Memory Task Performance	13.60	3.28	-0.21	-0.10	0.25	—	
5. Memory Task Self-Efficacy	4.18	0.59	-0.20	0.07	0.01	0.14	—

**M* and *SD* represent Mean and Standard Deviation.

Complex Direction Following.

By using a two-way ANOVA, age and gender were found to have no effect on Directional Task performance or self-efficacy (all p -values (ps) $>.4$), disproving H3 and reinforcing H4 with regards to following complex directions (see figure 1). To test the effect of persuasion on Directional Task self-efficacy and performance, a one-way ANOVA and a Chi-square test were used respectively. Results were not significant (both ps $>.4$), indicating that persuasion had no effect on either Directional Task self-efficacy or performance, disproving H1 and H2 with regards to following complex directions (see figures 2 and 3).

Short Term Memory

By using a two-way ANOVA, age and gender were found to have no effect on Memory Task performance (all ps $>.2$). However, while age and gender independently had no effect on Memory Task self-efficacy (both ps $>.4$), gender x age was shown to have a significant effect on Memory Task self-efficacy with a confidence interval of 95% ($p=0.03$), indicating that as females get older, they experience a greater decrease in self-efficacy than males (see figure 1), disproving both H3 and H4 with regards to memory. A one-way ANOVA analyzing the effects of group on short term memory self-efficacy and performance also yielded non-significant results (both ps $>.3$), see figures 2 and 3.

DISCUSSION.

Results demonstrated that verbal instruction, including both positive and negative persuasion, had no effect on self-efficacy or performance of both the Directional and Memory Tasks. One possible explanation for this finding is that high school students may already have relatively

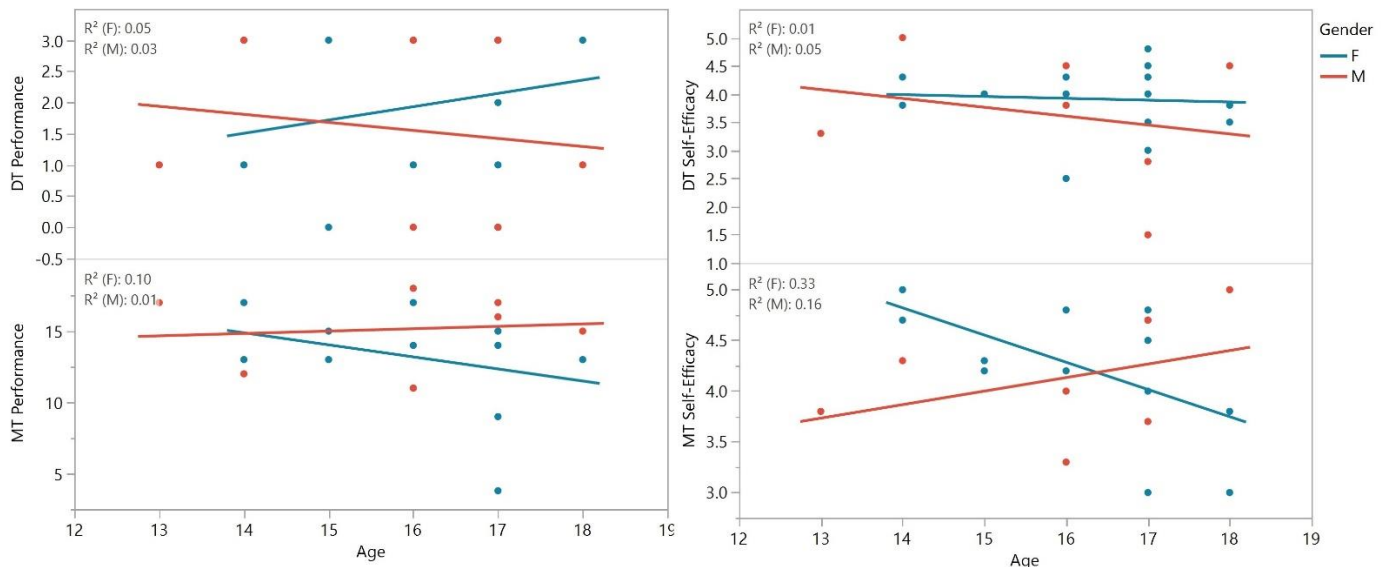


Figure 1. Effect of Age and Gender on Directional Task (DT) and Memory Task (MT) Self-efficacy and Performance. Higher numbers correspond to greater self-efficacy for both MT and DT self-efficacy. Higher numbers also correspond to better performance on both the MT and DT. For both tasks, performance scores from the test were averaged and higher numbers signify better performance. For the MT, the performance scores relate to how many numbers an individual was able to recall using short-term memory, so there was no set range for scores. For the DT, performance scores ranged from 0 to 3, with 3 being the highest score and indicating better performance. No significant effect of age or gender was found on DT self-efficacy and performance or MT performance (all $p > .4$). However, as age increases, Memory Task self-efficacy significantly decreases more for females than males ($p = 0.03$).

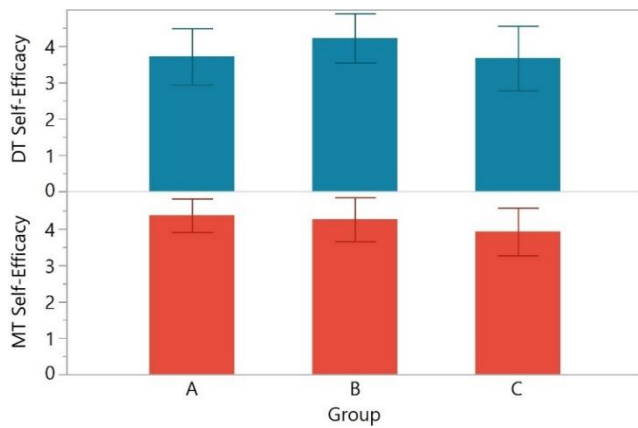


Figure 2. Effect of Verbal Persuasion on Directional Task (DT; blue) and Memory Task (MT; red) Self-Efficacy. Group A received positive verbal persuasion, Group B received negative persuasion, and Group C received no persuasion. Higher numbers correspond to greater self-efficacy. Analysis yielded no significant effect of group on either Memory Task self-efficacy or Directional Task self-efficacy (both $p > .4$).

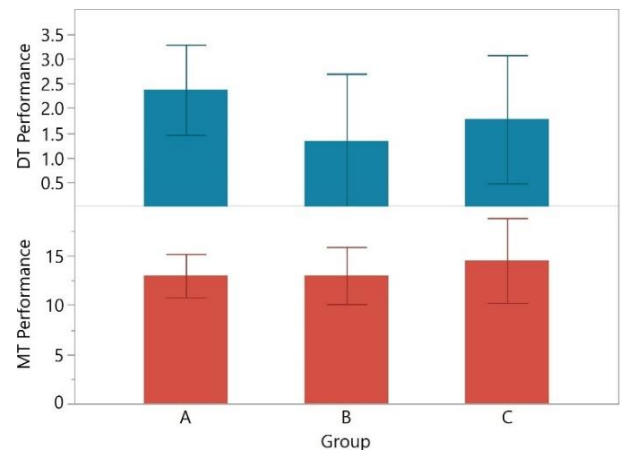


Figure 3. Effect of Verbal Persuasion on Memory Task (MT; red) and Directional Task (DT; blue) Performance. Group A received positive verbal persuasion, Group B received negative persuasion, and Group C received no persuasion. For both tasks, scores from the test were averaged and higher numbers signify better performance. For the MT, there was no set range for scores, but on the DT, scores ranged from 0-3, with 3 being the highest score. No significant effect of group was found on either Memory Task or Directional Task performance (both $p > .3$).

strong self-efficacy and mastery experiences concerning complex direction following and short-term memory, preventing any effect of experimental verbal persuasion [27]. This conclusion is supported by previous research that has suggested an indirect relationship between verbal persuasion and self-efficacy, where verbal persuasion would instead influence mastery experiences [14], [13]. Though the present research did indicate a non-significant relationship between verbal persuasion and self-efficacy, further experimentation testing specifically for their relationship could help to solidify this theory. For example, future studies could measure mastery experiences and administer verbal persuasion to determine if verbal persuasion can modify how an individual perceives their mastery experiences. Additionally, a lack of significant correlation between Memory and Directional Task self-efficacy, (shown in Table 1) could suggest high domain specificity for self-efficacy [15]. Another important finding of this

study was that Memory Task self-efficacy greatly decreased over the age range 13 to 18 for females when compared to males. This finding is bolstered by previous research showing that over time, self-efficacy in academics, including math, social science, and computer science, decreased significantly more for females than males [18], [28]. Future research could help to address what conditions cause self-efficacy to vary among males and females in both academic and cognitive domains.

This study had several limitations that should be taken into consideration before generalizing its findings to other situations. First, the sample size of this study consisted of only 23 participants from a limited range of academic abilities. Acquiring a greater number of participants from different academic backgrounds would create a more well-rounded sample. Another possible limitation was that testing materials

had to be administered virtually via a YouTube video and online surveys due to pre-existing pandemic conditions. This system did have some benefits, including each participant viewing an identical video and the ability to recruit participants who may live farther away, but each participant completed the study at different times or environments, which could potentially alter results.

Conclusions from this study are especially important for educators and mentors of children. Though verbal persuasion in this study was not found to have a direct effect on self-efficacy or performance, it is proposed that verbal persuasion could be pivotal in how an individual frames their mastery experiences. Therefore, educators should take care to highlight not a student's shortcomings, but instead their achievements and accomplishments. Additionally, because females tend to experience a significant decline in self-efficacy over time, special support should be given to females whose self-efficacy may be faltering, especially at a crucial period such as high school when an individual prepares for adulthood. Future research would focus on clearly identifying a relationship between verbal persuasion, mastery experiences, and self-efficacy, while exploring the implications of gender on this relationship.

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REFERENCES

1. "Self-Efficacy Teaching Tip Sheet." <https://www.apa.org.https://www.apa.org/pi/aids/resources/education/self-efficacy> (accessed Apr. 13, 2021).
2. A. Bandura, *Social Learning Theory*. (Prentice Hall, 1977).
3. P. R. Pintrich, D. H. Schunk, *Motivation in Education: Theory, Research, and Applications*. (Merrill, 2002).
4. A. Bandura, "Perceived self-efficacy in the exercise of personal agency." *J. Appl. Sport Psychol.* **2**, 128–163 (1990).
5. J. C. Hutchinson, T. Sherman, N. Martinovic, G. Tenenbaum, The effect of manipulated self-efficacy on perceived and sustained effort. *J. Appl. Sport Psychol.* **20**, 457–472 (Oct. 2008).
6. A. Bandura, *Social Foundations of Thought and Action: A Social Cognitive Theory*. (Prentice-Hall, 1986).
7. A. Bandura, *Self-Efficacy: The Exercise of Control*. (Macmillan, 1997).
8. F. Pfitzner-Eden, Why do I feel more confident? Bandura's sources predict preservice teachers' latent changes in teacher self-efficacy. *Front. Psychol.* **7** (2016).
9. A. Butz, E. Usher, Salient sources of early adolescents' self-efficacy in two domains. *Contemp. Educ. Psychol.* **42**, 49–61 (2015).
10. J. Cassé, M. Oosterman, C. Schuengel, Verbal persuasion and resilience of parenting self-efficacy: Preliminary findings of an experimental approach. *Fam. Sci.* **6**, 23–30 (2015).
11. D. Kiran, S. Sungur, Middle school students' science self-efficacy and its sources: examination of gender difference. *J. Sci. Educ. Technol.* **21**, 619–630 (2012).

12. F. Pajares, M. Johnson, E. Usher, Sources of writing self-efficacy beliefs of elementary, middle, and high school students. *Res. Teach. Engl.* **42**, 104–120 (2007).
13. T. Matsui, K. Matsui, R. Ohnishi, Mechanisms underlying math self-efficacy learning of college students. *J. Vocat. Behav.* **37**, 225–238 (1990).
14. F. Lopez, R. Lent, Sources of mathematics self-efficacy in high school students. *Career Dev. Q.* **41**, 3–12 (1992).
15. L. Hornstra, I. van der Veen, T. Peetsma, Domain-specificity of motivation: a longitudinal study in upper primary school. *Learn. Individ. Differ.* **51**, 167–178 (2016).
16. K. Caraway, C. Tucker, W. Reinke, C. Hall, Self-efficacy, goal orientation, and fear of failure as predictors of school engagement in high school students. *Psychol. Sch.* **40**, 417–427 (2003).
17. K. Tahmassian, N. Jalali Moghadam, Relationship Between Self-Efficacy and Symptoms of Anxiety, Depression, Worry and Social Avoidance in a Normal Sample of Students. *Iran. J. Psychiatry Behav. Sci.* **5**, 91–98 (2011).
18. L. Hornstra, *et al.*, Developments in motivation and achievement during primary school: A longitudinal study on group-specific differences. *Learn. Individ. Differ.* **23**, 195–204 (2013).
19. F. Wilson, *et al.*, An analysis of the role of gender and self-efficacy in developing female entrepreneurial interest and behavior. *J. Dev. Entrep.* **14**, 105–119 (2009).
20. F. Lunenburg, Self-Efficacy in the workplace: implications for motivation and performance. *Int. j. bus* **14**, 1–6 (2011).
21. M. Newlin, An examination of the effects of verbal persuasion on an individual's judgment of self-efficacy. *Diss Purdue University* (1998).
22. D. Hayward, R. Gillam, P. Lien, Retelling a script-based story: do children with and without language impairments focus on script and story elements. *Am. J. Speech Lang. Pathol.* **16**, 235–246 (2007).
23. H. Fink *et al.*, *Neuropsychological Test Descriptions*. Agency for Healthcare Research and Quality (US) (2014).
24. F. Ostrosky-Solis, A. Lozano, Digit Span: Effect of education and culture. *Int. J. Psychol.* **41**, 333–341 (2006).
25. "Attention and Concentration." <https://fpnotebook.com/Neuro/Exam/AtntnAndCncntrtn.htm>
26. J. Berry, R. West, D. Dennehey, Reliability and validity of the Memory Self-Efficacy Questionnaire. *Dev. Psychol.* **25**, 701–713 (1989).
27. "Cognitive Development, Ages 15 to 18 Years | CS Mott Children's Hospital | Michigan Medicine." <https://www.mottchildren.org/health-library/te7285> (accessed Jul. 02, 2021).
28. C. Huang, Gender differences in academic self-efficacy: a meta-analysis. *Eur. J. Psychol. Educ.* **28**, 1–35 (2013).



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