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Effects of Peer Growth Mindset and Social Comparison on Adolescents' Learning Outcomes

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ABSTRACT OF THE DISSERTATION

Effects of Peer Growth Mindset and Social Comparison on Adolescents' Learning Outcomes

by

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Children's belief in the malleability of intelligence, known as growth mindset, has been shown to predict numerous academic outcomes. Much attention has focused on the role of parents and teachers in the socialization of growth mindsets, while less research has examined children's peers. The influence of peers on children's academic functioning is well-documented, particularly during adolescence when children spend more time with their peers and look to them as reference points in order to gauge their own academic competence. However, such social comparison processes may be detrimental to students' academic self-perceptions and achievement, and their impact may depend on students' implicit beliefs about intelligence. Although there is growing attention on the role of peers in mindset socialization as well as past literature demonstrating the effect of peer mindsets on students' learning outcomes, the simultaneous consideration of peers' beliefs about intelligence and social comparison influences has yet to be studied.

This dissertation investigated the interplay between these two constructs and their effects on adolescents' motivational and academic outcomes using an online experimental paradigm to manipulate perceptions of peers' mindsets and competence. Participants (N = 120) heard statements reflecting different types of mindsets from purported peers, completed a series of surveys and activities, and received feedback on their and their peers' performance via a virtual leaderboard to induce social comparison. Results showed various main effects of the growth mindset and social comparison manipulations, but no interactive effects. Regardless of social comparison condition, growth mindset peers increased adolescents' learning conducive perceptions of themselves and both their self-reported and objective learning outcomes, while social comparison dampened learning conducive perceptions. The effects of peer growth mindset were partially explained by perceptions of peers' competence and identification with higher performing peers, a positive strategy when faced with a social comparison scenario. The findings further our understanding of peers in the transmission of intelligence beliefs and subsequent learning outcomes, which may inform future efforts geared toward improving adolescents' academic success.

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CHAPTER 1

Introduction

Students' belief in the malleability of intelligence, often referred to as growth mindset, has been shown to predict a variety of academic outcomes (Blackwell et al., 2007; Good et al., 2012). In their efforts to understand the role of social agents in fostering growth mindsets in the classroom, researchers have studied teachers and have implemented them into growth mindset intervention programs (Menanix, 2015; Seaton, 2018; Sun, 2015). As a result, in a recent US nationally represented survey, over 90% of teachers agreed that growth mindset is a key factor in students' academic success, and the majority of teachers reported regularly applying growth mindset practices in their classrooms (Yettick et al., 2016). However, amid this "mindset revolution," little attention has been paid to an equally present social agent in the classroom: the students' peers.

Peers have a substantial influence on one another, particularly during adolescence (De Goede et al., 2009). Academically, adolescence is a critical time during which individuals make choices about their future career paths and prepare for the transition from secondary school to college, a process that is greatly influenced by their peer affiliations (Yazedjian et al., 2007). Peer influence on educational outcomes is driven by numerous factors, including selection and socialization, but also by social comparison, as students look to their peers as a reference point in order to gauge their own academic competence and potential (Dijkstra et al., 2008). These social comparison processes

greatly influence students' academic self-perceptions, particularly their perceptions of competence, as well as their academic achievement. As such, social comparison and its resulting consequences may interact with students' implicit beliefs about intelligence to shape their academic trajectories. Although much of the growth mindset literature has examined adolescents in educational settings and there is growing attention on the role of peers, the simultaneous consideration of peers and social comparison influences has yet to be studied. Hence, an investigation of how peer endorsement of growth mindset and social comparison influence students' own mindset and learning outcomes represents a gap in the mindset literature. Concurrent investigation of these topics may reveal important implications for the development of intervention programs and inform further research on the role of peers in adolescents' functioning and future career paths.

This dissertation investigated the interplay between peer mindset and social comparison and their effects on adolescents' motivational and academic outcomes using an experimental paradigm in which participants' perceptions of peers' growth mindsets and their comparative standings relative to their peers were manipulated. Participants were middle school age adolescents ages 12-14, the developmental period during which peer influence is at its strongest (Berndt, 1979; Brown et al., 2008; De Goede et al., 2009), and a seminal time for self-concept and identity development (Harter, 1990). This study may further our understanding of the role of peers in the transmission of beliefs about intelligence and will help answer the question of how mindsets are socialized, which could inform future mindset intervention programs. Furthermore, examining the relationship between peer mindset and social comparison will provide insight into how

implicit theories of intelligence may operate during students' peer interactions in the classroom, which often involve evaluation and comparison, and elucidate the different contexts under which peer mindset operates to best influence students' learning.

Mindset Theory

Mindset theory posits that children's underlying beliefs about the origin of intelligence impact their academic achievement and motivation. According to Dweck (2000), individuals fall along a continuum of *fixed* to *growth* mindsets. On one end of the spectrum is the fixed mindset, the belief that intelligence is an innate entity that is stable and unchangeable. On the other end of the spectrum is the growth mindset, the belief that intelligence can be improved through practice and effort. Mindset theory arose from achievement goal theory, which is concerned with children's underlying objectives for achievement behaviors and how differing goals affect learning motivation (Dweck & Leggett, 1998; Elliot & Harackiewicz, 1996). Children who endorse fixed mindsets ascribe to performance goals: Their primary aim is to prove their ability to others through successful performance. On the other hand, children who endorse growth mindsets are more inclined to have learning goals: They are not as focused on performance but rather want to gain a deeper understanding of the subject material and master it (Dweck & Leggett, 1988; Payne et al., 2007).

These different theories of intelligence and their accompanying goal orientations affect children's responses to challenging tasks (Mueller & Dweck, 1998). When the task is easy, both fixed and growth mindset children show high engagement and persistence, but discrepancies arise once the task becomes difficult. For the fixed mindset child,

failure indicates lack of ability. Although performance to confirm their ability is the primary goal, rather than risk denouncing their ability through poor performance, these children will disengage from the task and exhibit a helpless response, undermining their achievement outcomes. However, because children with growth mindsets do not see failure as a lack of ability but instead as a learning opportunity, they persist through challenging tasks, remain motivated, and demonstrate better achievement outcomes (Mueller & Dweck, 1998). Corroborating this notion, Cho and colleagues (2019) found that growth and fixed mindsets were directly associated with mastery and performance goals, respectively, and that goal orientation completely mediated the effects of mindset on children's reading engagement and achievement. More specifically, growth mindset led to increased mastery goal orientation, which improved learning outcomes. These findings align with past literature illustrating the beneficial effects of mastery goal orientation on students' achievement (for a review, see Covington, 2000), though it is important to note that certain types of performance goals (i.e., performance approach goals) may have positive achievement effects as well (Harackiewicz et al., 1998; 2002). Consequently, mindset theory has many implications for children's achievement motivation and success in the academic arena. Endorsement of a growth mindset will positively impact learning and motivation, while endorsement of a fixed mindset will negatively impact educational outcomes.

Mindset and Achievement Outcomes

Much empirical literature has garnered support for mindset theory. Research in this area can be classified into two categories: studies on the effects of pre-existing

mindsets and studies on the effects of induced growth mindsets. Pre-existing endorsement of a growth mindset is associated with numerous educational advantages, including increased engagement and achievement (Blackwell et al., 2007; Bostwick et al., 2017), persistence (Aditomo, 2015), as well as decreased self-handicapping behaviors (Martin et al., 2013). These associations have been found in numerous age groups spanning young children to emerging adults. For example, in 7-9th graders, Bostwick et al. (2017) found that students who naturally endorsed a growth mindset earned higher mathematics grades and had increased mathematics engagement. In a study of undergraduates, Aditomo (2015) found that students with a growth mindset showed more motivation and persistence throughout the course of a difficult statistics class, ultimately achieving higher grades as well. Natural endorsement of a growth mindset also may serve as a protective factor for students of low socioeconomic status (Claro et al., 2106) and for those at risk for stereotype threat (Aronson et al., 2002; Good et al., 2012).

Research on induced mindsets, as opposed to naturally occurring mindsets, has emphasized the role of *process* versus *ability* praise (Mueller & Dweck, 1998; Gunderson et al., 2013). Process praise, wherein the teacher or parent praises the student based on effort (e.g., You did great, you must have worked really hard!) has been shown to promote a growth mindset, whereas ability praise, wherein the student's natural talent is emphasized (e.g., You did great, you must be really smart!) promotes a fixed mindset (Mueller & Dweck, 1998). As such, process praise and other methods of conveying a growth mindset, such as teaching students about the brain's plasticity and ability to grow (e.g., Donahoe et al., 2012), have been employed in various mindset intervention studies.

These interventions have had mixed results, with some proving effective at increasing achievement (Blackwell et al., 2007), and others showing no effects (Fabert, 2014). However, as emphasized in a meta-analysis by Sisk and colleagues (2018), these inconsistent findings do not necessarily mean that growth mindset interventions are ineffective. Rather, growth mindset may be more beneficial for students of particular demographics and circumstances, such as those facing academic challenge or low SES, compared to other students (Yeager & Dweck, 2020; Yeager et al., 2019). It may also be the case that certain methods of mindset transmission (e.g., teacher, online, or peer delivered), are more or less effective for different students. More research is needed to examine these additional potential moderators of mindset effects, as well as different methods of cultivating growth mindset in students. Notably, successful mindset manipulations have been administered incrementally over time (e.g., Blackwell et al., 2007), but also have proven effective using brief, single timepoint sessions (e.g., DeBacker et al., 2018; Paunesku et al., 2015).

Theories of Peer Influence

Peers refer to same-age individuals who share similar interests, identities, and interact with one another frequently (Sallee & Tierney, 2007). Like parents and teachers, peers make a unique contribution to children's development, taking center stage during adolescence (De Goede et al., 2009). Selection and socialization theories of peer influence postulate that peer groups self-select based on shared attitudes, interests and socio-demographics (McPherson et al., 2001), and become more similar over time via the creation of and adherence to group norms (Abrams & Hogg, 1990). Peers are most

influential when they are perceived as desirable and high in status (Cohen & Prinstein, 2006), and past research has shown that adolescents will model their behavior according to their perceptions of what is normative of their popular peers, regardless of whether or not their peers actually engage in these behaviors (Helms et al., 2014; Prentice & Miller, 1996). Hence, the purported attitudes and behaviors peers convey to one another shape individuals' beliefs and choices. When children enter adolescence, they spend increasingly more time with peer groups, making peers substantial socializing agents during this age that greatly impact students' academic beliefs and achievement (Rodkin & Ryan, 2012; Ryan, 2000).

Peers and Achievement Outcomes

Peers play a major role in students' academic lives (for a review, see Rodkin & Ryan, 2012). Past research has shown that peers influence not only one another's academic achievement (Wentzel & Caldwell, 1997; Gallardo et al., 2016), but also affect school behavior (Berndt et al., 1999), motivation-related beliefs about school (Altermatt & Pomerantz, 2003), engagement (Kindermann, 2007) and school adjustment (Wentzel et al., 2004). For example, Kindermann (2007) found that students' peer group levels of academic engagement predicted their own engagement throughout the school year, while Gallardo et al. (2016) found that peer acceptance predicted increased student achievement. Such positive associations of peers on students' learning have also been shown to persist through college (Ashwin, 2003; Zimmerman, 2003).

Although little research has specifically investigated how peer beliefs about intelligence influence students' achievement, there is some research heading in this

direction. For example, Laninga-Wijnen and colleagues (2018) found that, in classrooms in which mastery goals were a perceived norm, there was an increased influence of friends on students' achievement, compared to classrooms with perceived performance goal norms. Other research by Poortvliet et al. (2009) has shown that individuals primed to endorse mastery goals were perceived as more cooperative and helpful to others, and provided them with more useful information. As mastery goals are an integral component of the growth mindset, it may be the case that peers who communicate a growth mindset viewpoint are more influential toward their fellow students' beliefs as well as facilitative of their learning outcomes.

Two longitudinal studies provide further evidence for peer effects on growth mindset. In a study of high school students, King (2020) found that the mindsets of students' classmates predicted their own mindset endorsement, even after controlling for their previous mindset 7 months earlier. Additionally, a report on the National Study of Learning Mindsets examined the effects of peer norms on a growth mindset intervention (Yeager et al., 2019). This longitudinal study involved a brief, online mindset intervention that was delivered to a nationally representative sample of 9th grade high school students. Results of the study indicated a moderation of peer norms on students' post-intervention grades, such that students' grades increased after the mindset intervention when peer norms corresponded to growth mindset-oriented behaviors (i.e., challenge-seeking). These findings garner support for the idea that peer mindset environment influences both students' own mindsets as well as their achievement outcomes and highlights the need for more research in this area.

Peers and Mindset Transmission

Theories of mindset transmission via socialization by parents and teachers have traditionally focused on the role of person versus process praise. For example, in Mueller and Dweck's (1998) seminal mindset study, process praise (praise for effort) was used to induce growth mindset in the participants, while person praise (praise for ability) was used to induce fixed mindset. Other research has added support to this notion by showing that parents' use of effort praise with their children at one to three years of age predicted growth mindset endorsement five years later (Gunderson et al., 2013), and teacher use of person praise predicted fixed mindset-type responses to failure in undergraduate students (Skipper & Douglas, 2012). These studies indicate that the types of messages parents and teachers communicate to children through praise can facilitate their mindset endorsement.

Unlike parents and teachers, peers represent a different type of relationship because there is equal status between the two social partners, referred to in the literature as a horizontal relationship (Hartup, 1989). Praise more often occurs in vertical relationships where one partner has authority over the other, such as in parent-child relationships. Rather, peer relationships, particularly in adolescence, often involve mutual exchange and self-disclosure (Rubin et al., 2007), and peer effects are largely driven by perceptions of popular behaviors and attitudes (Helms et al., 2014). Thus, it may be more appropriate to prime mindsets using peer self-statements, and to measure indicators of peer influence such as the individual's identification with the peers and perceptions of their abilities. Accordingly, the current research used an alternative method for studying mindset influence in the peer context – by manipulating the types of statements (i.e.,

effort vs ability) peers express regarding a challenging task, in order to communicate peer mindset beliefs.

Peers and Social Comparison

Peers influence one another not only through selection and socialization, but also through social comparison processes. According to the theory of social comparison, humans possess a fundamental drive toward self-evaluation and self-improvement and consequently look to others as a means to accomplish these goals (Festinger, 1954). In the classroom, social comparison is a ubiquitous, often unavoidable part of students' educational experience. The frequency and duration of social comparison behaviors in the classroom increases with age and has been observed as early as kindergarten (Ruble et al., 1976), with overt comparison behaviors more prevalent in younger children and older children exhibiting more subtle comparison behaviors (Pomerantz et al., 1995). Social comparison takes on different forms and functions for the individual and carries with it both costs and benefits (Dijkstra et al., 2008). For instance, though social comparison has been shown to increase academic achievement, it also may interfere with students' motivation to learn through diminished feelings of competence and academic self-concept (Altermatt & Pomerantz, 2005; Raat et al., 2013). These effects are often contingent on the type of social comparison and the individuals' resulting self-perceptions.

Social comparison manifests in three different ways: upward, downward, and lateral (Djikstra et al., 2008). Upward comparison occurs when students compare themselves with others who are deemed more competent than themselves, while

downward comparison occurs when students compare themselves with worse others. Lateral comparison occurs when students compare themselves to others who are equal in ability. Festinger's (1954) theory of social comparison postulates that individuals choose to engage in upward comparison when they seek to improve their abilities, referred to as self-improvement, lateral comparison when they want to evaluate their own abilities, and downward comparison when they want to feel better about themselves, referred to as self-enhancement. There is some empirical work in support of these notions. For example, in a study by Ruble and colleagues (1976), 2nd grade participants often reported engaging in upward social comparison for task-oriented reasons, such as wanting to know how the other participant was performing while completing a task (coloring), and also exhibited increased effort after comparing, suggesting an aim toward self-improvement. In the same vein, Huguet et al. (2001) found that the majority of students ages 12-14 years chose to engage in upward comparison for self-improvement reasons.

Achievement of the goals that motivate social comparison depends on the individual's level of identification or contrast with the comparison target (Djikstra et al., 2008). In the case of upward social comparison, identification is optimal. For example, if a student compares her exam score with another student who has outperformed her for the purpose of learning how she can perform better on a subsequent exam score, she must see herself as similar enough to the other student in order to believe that she too is capable of improving her score. This explains why, when seeking upward comparison targets, students tend to choose peers who are similar to themselves in terms of gender, race, and age (Blanton et al., 1999; Dumas et al., 2005; Huguet et al., 2001). Conversely,

in situations of downward comparison, it is better to contrast with the target. If the student compares her exam with another student who has underperformed her, she should see herself as dissimilar to the other student, lest she think she might also perform poorly on the next exam.

Focusing on the educational context, the theory of social comparison argues that the type and resulting identification/contrast students experience with their classmates shapes their perceptions of academic competence, self-concept, and future potential, which consequently affect their achievement outcomes (Djikstra et al., 2008). In the same vein with the stereotype threat literature, students' identification and contrast with groups shapes not only their perceptions and concerns regarding how they will be viewed by others, but also their perceptions of themselves, known as *self-stereotyping* (Sinclair et al., 2006). If students contrast with higher achieving peers and/or identify with lower achieving peers, these resulting self-stereotypes could dampen their perceptions of competence and alter their behavior in the classroom, which can significantly impact them academically (Chouinard et al., 2007; Schunk & Pajares, 2005).

Social Comparison and Achievement Outcomes

In educational settings, the most frequent mode of social comparison reported by students is upward social comparison (Blanton et al., 1999; Pulford et al., 2018; Wehrens et al., 2010). Some research suggests students who compare with higher-achieving peers have increased academic achievement (Gremmen et al., 2018; Jackson, 2013; McVicar et al., 2016; Wehrens et al., 2010). However, other research refutes this notion, either by showing no effects of upward social comparison on achievement (Dobbie & Fryer, 2014;

Jonsson & Mood, 2008) or negative effects (Véronneau & Dishion, 2011). Regarding downward social comparison, some research has paralleled the effects of upward comparison (e.g., students with lower-achieving peers had decreased academic achievement), but other research has found no negative effects on achievement (McVicar et al., 2016).

Past literature on the affective outcomes of social comparison has revealed that, regardless of whether it is upward or downward, social comparison may increase students' evaluative anxiety (Butler, 1989), stress (Bossong, 1985), and sadness (Hokoda et al., 1989). More recent findings pertaining specifically to upward comparison reveal mostly negative effects, including decreased academic self-concept (Trautwein et al., 2009), perceptions of competence (Altermatt & Pomerantz, 2005), self-esteem (Harvey & Keyes, 2019), and increased math anxiety (Erdoğan et al., 2011). In contrast, some research suggests engaging in downward comparison may have beneficial consequences, such as increased perceptions of competence and positive affect (Steinbeis & Singer, 2013; Chayer & Bouffard, 2010). In line with these findings, other research indicates that students especially prefer to engage in downward social comparison when they are feeling stressed (Suls & Wheeler, 2000) or after they have suffered an academic setback (Aspinwall & Taylor, 1993). However, as highlighted earlier, the effects of social comparison often depend on the level of identification or contrast the individual has with the comparison target. For example, Buunk and colleagues (2005) found that when students engaged in upward social comparison but also identified with the higher-achieving peer, they were less likely to experience resentment, worry, and were actually

more inclined toward positive affect and feelings of encouragement about their own their future potential. Hence, it is important to consider both students' direction of social comparison as well as their resulting self-perceptions when evaluating social comparison effects on educational outcomes.

Mindset and Social Comparison Effects on Academic Pursuits

Scant research has examined the joint effects of social comparison and growth mindset on academic outcomes concurrently. One study of undergraduates by Nussbaum & Dweck (2008) examining these two constructs revealed an interesting relationship. Students primed to endorse a fixed mindset more frequently engaged in downward comparison (choosing to review strategies of a lower performing other) as a means of self-esteem repair following a failure experience. On the other hand, students primed with a growth mindset engaged in less downward comparison and more frequently chose to compare with an individual who had outperformed them as a means of self-improvement. This study demonstrates the link between growth mindset and social comparison, supporting the notion that implicit theories of intelligence prompt the adoption of different goals in times of challenge, which are accomplished via different types of social comparison.

Other research, though not examining mindset explicitly, has examined its associated mastery and performance goal orientation on social comparison consequences. Following induced upward social comparison, Carmona et al. (2008) found that students who were focused on failure prevention (performance-avoidance goals) were more likely to contrast with the upward comparison target, which resulted in decreased self-efficacy

and achievement outcomes. Conversely, in another study by Kamarova and colleagues (2017), the adoption of mastery goals resulted in increased positive mood and perceptions of competence following an upward social comparison experience. According to researchers, these results can be explained by the mastery goal advantage effect, which argues that mastery-approach goals protect students from the harmful effect of upward social comparison on perceptions of competence. This effect also has been documented in studies examining students' responses to negative feedback (e.g., Lee & Kim, 2014).

Because the mastery goal orientation is argued to be a consequence of growth mindset (Dweck, 2000), endorsement of this implicit theory of intelligence may aid students in the mastery goal advantage effect, motivating them to engage in behaviors post-upward social comparison that are beneficial to their learning while protecting them from its negative consequences. In support of this, a growth mindset intervention by Micari and Pazos (2014) found that participants who received training about the malleability of intelligence experienced less concern about social comparison when working in groups compared to those who had not received the training, the effects of which were especially strong for students of lower ability. Taken together, these findings underscore the need to further examine how mindset and social comparison processes interact to affect students' learning outcomes, particularly in the peer context where many of these comparison experiences occur.

Early Adolescence as a Unique Developmental Period

Early adolescence is a time marked by numerous biological, social, and cognitive changes that coincide with additional changes in students' educational environments

(Eccles et al., 1993). In contrast to elementary school, when students typically remain with the same class and a single teacher throughout the school year, middle school often involves larger class sizes and multiple teachers as well as increases in teacher restrictiveness, performance evaluation, and decreased quality of teacher-student relationships (Lynch & Cicchetti, 1997; Wu & Hughes, 2015). These changes are at odds with adolescents' desire for increased autonomy and intimacy during this period of development (Eccles & Midgley, 1989; Feldlaufer et al., 1988). According to stage-environment fit theory, this lack of fit manifests in students' decreased academic achievement and engagement at this age (Eccles & Midgley, 1989; Eccles et al., 1993). Consistent with this theory, many students show declines in motivation and academic performance after entering middle school (Eccles & Midgley, 1989; Harter, 1981), and middle school students report decreases in academic, personal, and interpersonal functioning, particularly when transitioning from sixth to seventh grade (Barber & Olson, 2004).

Additionally, adolescence is a critical time for self-concept and identity formation (Harter 1990), a process that is greatly influenced by peer affiliations. Adolescents spend more time with their peers than with their parents (Brown & Larson, 2009; Larson & Richards, 1991), and compared to elementary school students, middle school students report more positive relationships with their peers than with adults (Lynch & Cicchetti, 1997). Due to this shift, as students enter adolescence, they are increasingly influenced by their peers' attitudes and behaviors, both socially and academically (De Goede et al., 2009). Furthermore, the transition from elementary to middle school brings an increase in

the role of perceptions of competence on students' self-concept (Zanobini & Usai, 2002). For this reason, social comparison processes may be especially relevant at this age, as individuals look to others in order to evaluate themselves and their capabilities. Due to decreases in motivation and achievement as well as increased susceptibility to peer pressure and self-evaluation, early adolescence is an optimal developmental period to study peer mindset and social comparison influences as a possible avenue to counteract these negative achievement effects.

Overview of the Current Research

Drawing from mindset theory, theories of peer influence, and social comparison theory, the present study examined the effects of peer growth mindset endorsement and social comparison experiences on middle school students' mindset endorsement, academic self-perceptions, and learning outcomes. Based on past literature demonstrating the positive effects of growth mindset on academic achievement and the wealth of research on peer influence in adolescence, it was expected that adolescents' growth mindsets would be influenced by peer beliefs, which would subsequently affect their motivation and learning outcomes. However, because peer interactions in the educational context often involve social comparison, which independently influences students' academic perceptions and achievement, it was expected that growth mindset would moderate this relationship, serving to provide a buffer against the negative impact of upward social comparison.

A prior line of work examining peer mindset environment and learning outcomes in undergraduate students (Sheffler & Cheung, 2020) demonstrated that peers who

endorsed a growth mindset were perceived by others to be more competent than peers who endorsed a fixed mindset, and interactions with these growth mindset peers resulted in increased task value, an important learning outcome. However, this experimental study left many unanswered questions. Because the study was conducted with undergraduate students, it is not known whether similar peer effects would be observed in adolescents. Due to the heightened role of peer influence in adolescence, it is possible that peer mindset effects could be stronger and affect other learning outcomes beyond task value. Furthermore, it is not known how the individual's own competence perceptions and comparisons with peers' competence are influenced by growth mindset, nor whether growth mindset may serve as a buffer against negative comparison experiences, which could reveal critical knowledge about the function of growth mindset in adolescents' daily academic interactions with classmates.

To address these research gaps, this experimental study manipulated adolescents' perceptions of their peers' implicit theories of intelligence and competence via a forced social comparison experience. Peer groups were simulated in an online setting using avatars that were purportedly created by previous adolescent participants. Participants read and listened to statements they were led to believe their peers expressed. Social comparison was manipulated by providing feedback on the activity and visually representing the participant and their peers' scores using a virtual leaderboard. Assessing participants' baseline growth mindsets, manipulating their peers' mindsets, and prompting a social comparison experience allowed investigation of adolescents' pre-existing growth mindset and peer mindset influences as well as how growth mindset

affects the consequences of social comparison on their learning. By utilizing a middle school aged sample, I was able to examine peer mindset effects in adolescents at the ideal developmental stage when peer influence is most salient. Additionally, by directly manipulating perceptions of peers' competence via social comparison, I was able to test peer competence as a mechanism of mindset transmission and examine self and peer growth mindset influences on motivation and learning outcomes.

Research Hypotheses

The current study examined the following hypotheses:

1. It was expected that peer growth mindset endorsement would predict increased participant growth mindset, which would subsequently lead to improved learning-related outcomes, including effort, value, perceptions of competence, mastery behaviors, and objective performance (see Figure 1).

Figure 1

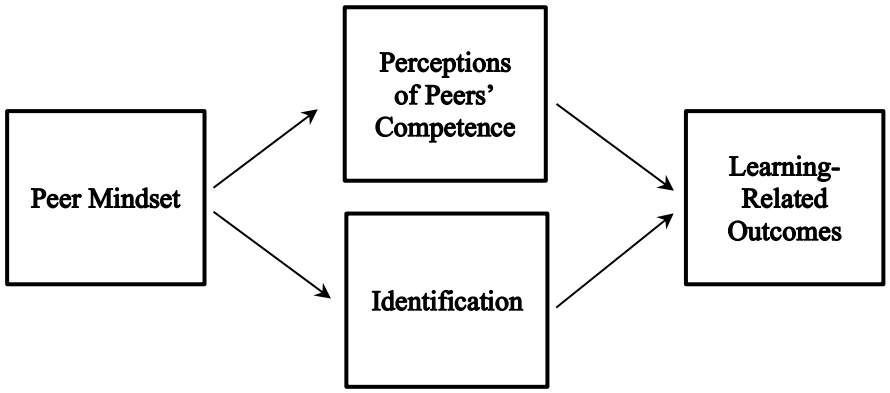
Conceptual Framework Testing Hypothesis 1

2. Upward social comparison would predict decreased learning-related outcomes and increased negative learning-related consequences, including test anxiety and upward contrast.

3. In accordance with past literature on upward social comparison and academic outcomes, it was expected that peer growth mindset would interact with social comparison, such that it would lessen the negative learning-related consequences of upward social comparison.
4. Replicating the relationship between growth mindset and perceptions of peers' competence in the adolescent sample, it was expected that growth mindset peers would be perceived as more competent than neutral mindset peers, and these increased competence perceptions would mediate the relationship between peer growth mindset and learning-related outcomes. Upward identification with peers was also examined as a potential mechanism of peer growth mindset effects on learning-related outcomes.

Figure 2

Conceptual Framework Testing Hypothesis 4



CHAPTER 2

Method

Design

This experimental study utilized a 2x2 factorial design in which participants heard statements from purported peers and completed a series of problem-solving tasks. The two independent variables included manipulation of peers' mindsets (growth or neutral) and manipulation of the participants' perceptions of peers' competence (peers outperform or perform equally as well as the participant), resulting in a forced social comparison scenario. Dependent variables included participant endorsement of growth mindset, social comparison identification and contrast, achievement goal orientations, self and peer perceptions of competence, numerous learning outcome assessments: objective performance, task value and effort, mastery behaviors (persistence, effort, resilience, challenge-seeking), and self-regulated learning strategies.

Participants began the study by creating an avatar to virtually represent themselves and then completed a questionnaire. Before beginning the series of problem-solving tasks, participants were introduced to four other peer avatars, and heard and read statements about the task that they were led to believe were written by their peers. These statements included peer endorsement of either a growth implicit theory of intelligence or a neutral statement regarding the task. Then, a brief survey assessed participants' initial perceptions of their peers, and participants completed the first problem-solving task. After completion of the first problem-solving task, social comparison was induced by providing the participants with false feedback regarding their and their peers'

performance via a leaderboard with the participants' and their peers' avatars' scores. After the social comparison, a brief manipulation check ensued, followed by a second battery of problem-solving tasks and final questionnaire. See Appendix A for a breakdown of measures in each survey.

Participants

Participants were 120 middle school age adolescents (*M* = 12.73 years, *SD* = 0.82) recruited from the University of California, Riverside Child Studies participant pool. In order to be eligible for the study, participants were required to be between the ages of 12-14 to ensure they were in the middle school age range, and be fluent in English to be able to complete the surveys and activities. Participants were 57.5% female, 39.2% male, and 3.3% other (i.e., gender-fluid, non-binary), and were of diverse ethnic background (31.1% White, 30.3% Multiracial, 29.4% Hispanic/Latinx, 5.9% Black, 1.7% Asian or Pacific Islander, 1.7% American Indian or Alaskan Native). The sample size of 120 (30 per group) approximates the sample size of 128 that was calculated using G*Power (Faul et al., 2007) for a 2x2 factorial ANCOVA and determined to be the number necessary to detect medium effect sizes. All eligible participants from the UCR Child Studies database were contacted (approximately 1,280). However, due to difficulties with recruitment, 120 was the maximum sample that could be obtained. As compensation for their time, participants were emailed a $10 Amazon, iTunes, Starbucks, or Target gift card upon completion of the study. Missing data were low (0.8%) and were evaluated using a missing value analysis in SPSS (Little, 1988). Results of the analysis indicated that the missing data were missing completely at random (MCAR), evident by a

nonsignificant χ^2 value, χ^2 (102) = 118.67, p = .124. As such, imputation methods for missing data were not needed, as the missing data were not associated with the values of any of the observed or unobserved variables (Scheffer, 2002).

Procedure

Participants were invited to participate in the study via email, text, or phone invitation. An opt-in procedure was used for recruitment, such that parents must provide consent for their children to participate in the study and adolescents must provide assent. Parents and children received these forms with the study appointment confirmation email and were prompted to provide an electronic signature in an online form indicating their agreement to participate. The researcher explained that the purpose of the study was to understand how adolescents learn in an online environment. Upon obtaining parental consent as well as child assent, the researcher proceeded with a one-time Zoom appointment with the child participant. During the Zoom appointment, the participant completed several questionnaires and two sets of problem-solving activities. The researcher remained available on Zoom throughout the study appointment to answer any questions, and communicated to the participants that they were free to discontinue the study at any time without consequence. Parents were permitted to be present at the beginning of the study and at the end to verify receipt of the gift card, but were not permitted to be present during the study so as not to influence participants' responses.

A flowchart illustrating the study paradigm is included in Appendix B. At the start of the study, the participant was greeted in Zoom by the researcher, who explained the purpose of the study and instructed the participant to create an avatar using the

Nintendo® Mii Studio program (see Appendix C). The purpose of creating an avatar was to enable participants to visually represent themselves and simulate a peer group in a virtual environment. After creating their avatar, participants were given a link to the first questionnaire, distributed via Qualtrics. The purpose of the first questionnaire was to measure pre-existing growth mindset and assess baseline achievement and social comparison related variables (i.e., competence, goal orientation, challenge-seeking, and general social comparison tendency).

Upon completion of the first questionnaire, the peer mindset manipulation took place. The researcher shared their screen with the participants, showing them the avatars of four other purported participants alongside their own avatar. Participants were told "I would like to introduce you to four other kids who are about your same age and participated in the study earlier. After the study they recorded their thoughts about the activity." The researcher then pointed to the screen, and, indicating with the mouse, said "So here you are. And here are your four peers, Emma, Sophia, Jacob, and Ethan." Participants were then distributed a survey link where they were instructed to click on each peer's avatar to hear their thoughts about the problem-solving activity. In the growth mindset condition (see Appendix D), participants heard statements from their purported peers such as "I've heard about these types of tests before. They measure certain types of intelligence. With practice, you can improve your score." and "After you do the activity, you receive your score. I think if you keep trying, you can always do a little better." In the control condition (see Appendix E), participants received statements of the same length and tone but without growth mindset references, such as "I was told to work on the

activity, and it took about 10 minutes for me to complete it. After you do the activity, you receive your score." and "There were different kinds of questions. I spent more time on some of the problems than on others." The peer statements appeared in speech bubbles to the right of each avatar and were also spoken aloud. The statements were recorded by two adolescents of the same age as the participants (one 12-year-old male and one 14-year-old female), and the pitch was adjusted for two of the avatars so that the voices sounded as though they originated from four different individuals. Participants were instructed to click on each avatar before proceeding to a brief survey, which measured initial perceptions about the purported peers (i.e., perceptions of competence), and a timer ensured participants could not advance to the next screen before having heard all of the statements. The timed presentation of the statements also served to bolster the fidelity of the mindset manipulation.

After completing the brief survey, participants were introduced to the first problem-solving activity, which consisted of a spatial reasoning task (Raven's Progressive Matrices). The researcher explained how to complete the task with an example item, then distributed a survey link to the first set of 10 problems. Participants were given 10 minutes to complete it. Upon completion of the first problem-solving task, the second manipulation was conducted. Participants were told "Now that you are done with the first activity, I'd like to show you how you performed compared to your peers…Your score has been added to our leaderboard of past participants' scores." The participants were then shown a leaderboard with their and their peers' scores listed next to their avatar in order of highest to lowest score (see Appendix F). In the neutral (no

comparison) condition, the leaderboard indicated that the participants performed well, with a score of 89/100, which is between their peers' scores toward the top of the leaderboard, indicating that both the participant and their peers performed equally well. In the upward comparison condition, the leaderboard indicated that the participants performed poorer than the majority of their peers, ranking third lowest with a score of 47/100. Following this feedback, the researcher instructed the participant to complete a brief manipulation check survey to ensure the social comparison manipulation was effective. Then, upon completion of this questionnaire, the participant completed a second problem-solving task, followed by a second questionnaire. The purpose of the second questionnaire was to measure changes in growth mindset endorsement, social comparison identification and contrast, and several learning-related perceptions and outcomes (e.g., task self-competence, effort, value, and engagement).

After completion of the second questionnaire, the researcher debriefed the participant. The researcher explained that the true purpose of the study was to examine peer and social comparison effects on adolescents' views about intelligence and learning outcomes. The researcher clarified that the feedback the participant received about their score was not indicative of their actual score, and that the peer statements they heard as well as their peers' performance were fictitious. The researcher then distributed the gift card via email, and a parent joined the Zoom session to verify receipt of the gift card by signing an online form. After answering any questions the participant or parent had, the researcher ended the Zoom meeting, concluding the study.

Measures

Study measures included student self-report measures as well as objective measures of student engagement and performance on the problem-solving task. Data were collected in 4 online questionnaires distributed via Qualtrics. The first questionnaire (see Appendix G) was completed prior to the experimental manipulations and included measures of perceptions of academic self-competence, achievement goal orientation, challenge-seeking, effort, general social comparison, implicit theories of intelligence, and demographics. Then, a brief survey assessing participants' initial competence perceptions of their peers was delivered after the mindset manipulation (see Appendix H), and a brief manipulation check consisting of a few competence items took place after the social comparison manipulation to ensure its effectiveness (see Appendix I). The second survey packet (see Appendix J) was distributed after the experimental manipulation and included social comparison contrast and identification, implicit theories of intelligence, task-specific achievement goal orientation, perceptions of competence in the task for self and peers, task anxiety, task value, task effort, and self-regulated learning. Participants' scores on the problem-solving tasks were collected as a measure of objective performance, and the second problem-solving task was utilized both for objective performance and mastery behaviors (see Appendices K-L).

General Perceptions of Academic Self-Competence. This 4-item scale adapted from Wigfield et al. (1991) assessed students' general perceived competence in school (e.g., "How good are you at school?" 1 = Not at all good to 7 = Very good). This measure had acceptable reliability, $\alpha = .80$.

General Achievement Goal Orientation, Challenge-Seeking, and Effort. Four items measured participants' learning (e.g., "How important is it to you that you learn a lot in school?") and performance (e.g., "How important is it to you to do well in school?") goal orientations, challenge-seeking (e.g., "How much do you like to do difficult work in school?"), and effort (e.g., "How much effort do you put into your schoolwork?") (Wigfield et al., 1991; Pomerantz et al., 2000). These single construct items were administered to assess their general associations with growth mindset and social comparison tendency.

General Social Comparison. The short version of the Iowa-Netherlands Comparison Orientation Scale (Gibbons & Bunk, 1999; Schneider & Schupp, 2014) measured participants' underlying tendencies toward social comparison. This scale consists of 6 items on a 5-point scale (1 = Strongly disagree to 5 = Strongly agree). Example items include "I always pay a lot of attention to how I do things compared with how others do things" and "I am not the type of person who compares often with others" (reversed). A confirmatory factor analysis indicated that this measure aligned best as two factors (one 4-item and one 2-item factor). Both factors had poor reliability, and could not be improved by removing items. The 4-item factor with the better reliability, $\alpha = .65$, was used for subsequent analyses, and parallel models using the 2-item factor did not differ from the 4-item factor.

Implicit Theories of Intelligence. Six items adapted from Dweck (2000) were used to measure participants' implicit theories of intelligence. Participants indicated the degree to which they agreed with each statement on a 5-point scale (1 = Strongly disagree

to 5 = Strongly agree). Example items include “No matter how much intelligence you have, you can always change it quite a bit” and “Your intelligence is something very basic about you that you can’t change very much” (reverse-coded). Reliability analyses indicated that initial reliability was beyond the conventionally accepted level, $\alpha = .68$. Removal of two items, “The harder you work at something, the better you will be at it” and “Truly smart people do not need to try hard (reverse coded)” were removed to achieve an improved Cronbach’s alpha of .76. This 4-item growth mindset measure was used in all subsequent models, which did not differ when the 6-item measure was included. Post-test growth mindset reliability for the four-item measure was also acceptable, $\alpha = .77$.

Self-Regulated Learning. This 12-item instrument adapted from Dowson and McInerney (2004) measured participants’ methods and use of strategies when learning new material. Item wordings were altered to capture self-regulated learning strategies specific to the problem-solving activities. The measure included 3 of the original 5 subscales: elaboration (e.g., “When working on the activity, I tried to see how things fit together with things I already know”), monitoring (e.g., “I checked to see if I understood the things I was trying to learn during the activity”), and planning (e.g. “When doing the activity I picked out the most important parts first”). This instrument achieved high reliability, $\alpha = .92$.

Social Comparison Identification and Contrast. This 6-item instrument adapted from Van Der Zee (2000) and Kang et al. (2013) for the academic setting was used to measure participants’ identification and contrast with their peers following a

social comparison experience. Participants were asked to "Think about how you felt after receiving feedback on your peers' performance on the problem-solving task." Half of the items measured identification with an upward comparison target (e.g., "I realize it is possible for my score to also improve") and half of the items measured contrast with an upward comparison target (e.g., "It is threatening to notice that I am doing not so well on the problem-solving task."). Both subscales achieved acceptable reliability, $\alpha = .76$ (identification) and $\alpha = .80$ (contrast).

Perceptions of Competence in the Task for the Self and Peers. Eight items measured on a 5-point scale (1 = Strongly disagree to 5 = Strongly agree) assessed participant's perceived self-competence and peers' competence at the problem-solving task (Bandura, 1986). Items 1-4 measured the participants' perceptions of their own ability (e.g., "I feel confident in my ability to improve at the task") and items 5-8 measure their perceptions of their peers' ability (e.g., "They are capable of learning the material in the task"). Reliability was acceptable for both self-perceptions, $\alpha = .85$, and peers' perceptions of competence, $\alpha = .85$.

Task Anxiety. An adapted version of the short form Test Anxiety Inventory (TAI) (Spielburger, 2010; Taylor & Deane, 2002) was used to measure participants' test-related anxiety regarding the problem-solving task. This instrument consisted of 5 items and was measured on a 5-point scale (1 = Strongly disagree to 5 = Strongly agree). Example items include "During the problem-solving task I felt very tense" and "During the problem-solving task I felt so nervous that I forgot facts I really know." Reliability was acceptable, $\alpha = .86$.

Task Value and Effort. Adapted from Pomerantz et al. (2000), this 8-item instrument measured the degree to which participants viewed the problem-solving task as personally meaningful to them and the degree of effort they invested in it. Half of the items were designed to capture task value (e.g., "It's important to me to get the right answers on the problems" and the other half to capture task effort (e.g., "I made sure I understood each step of the problems"). Both subscales achieved acceptable reliability, α = .81 (task value), and α = .82 (task effort).

Initial Competence Perceptions at the Problem-Solving Task. Four items adapted from Wigfield et al. (1991) assessed students' perceptions of their own and their peers' competence at the problem-solving task (e.g., "Compared to others, how well do you think you/your peers will perform on the problem-solving activity": 1 = a lot worse than others to 5 = a lot better than others). These items were distributed as the Brief Survey (see Appendix H). Cronbach's alpha was acceptable for self-competence, α = .73, but was poor for peers' competence, α = .53.

Social Comparison Comprehension. Participants' understanding of the social comparison manipulation was assessed with 3 items (e.g., "Compared to your peers, how well did you perform on the problem-solving activity?": 1 = Not at all well to 5 = Very well). These items were distributed as the Manipulation Check (see Appendix I). Self-competence reliability was high, α = .94. Other competence reliability could not be calculated as it was a single item.

Problem-Solving Tasks and Objective Mastery Behaviors. Participants completed two sets of problem-solving activities consisting of Raven's Progressive

Matrices (Raven et al., 1977), an abstract reasoning measure in which participants identify the missing piece to a visual pattern. The first set contained both medium and difficult Raven's progressive Matrices items selected by the researcher and designed to be challenging for the participants (see Appendix K). Average performance (out of 10) on this first set indicated that it was indeed challenging for participants, $M = 5.05$, $SD = 1.78$.

The second set consisted of the PERC Task, an established measure that uses Raven's Progressive Matrices to assess mastery behaviors, including persistence, effort, resilience, and challenge-seeking (Porter, 2020; see Appendix L). This task begins with four easy Raven's Matrices items to assess baseline ability, then assesses challenge-seeking by asking participants if they would like to do easier or harder puzzles for the next set. Subsequently, participants receive three Raven's items of medium difficulty level and are given the option to view tips on how to solve each problem. The total time spent on these items and tips captures effort. Then, participants are given one easy item (for a break), followed by four difficult items. Time spent on the four difficult items was assessed as a measure of persistence. Participants finish the task with three easy problems, and the percent correct on this set measures resilience. The overall PERC measure of mastery behaviors was calculated using the SPSS script provided by Porter (2020) that was utilized during its original construction. Effort and persistence sub scores were corrected for skewness using a square root transformation and Winsorized outlier values to 3 standard deviations from the adjusted mean, and were then rescaled to achieve a range of 0 to 1. These scores were then added to the challenge-seeking sub score

(binary item: 0 no challenge-seeking, 1 challenge-seeking) and resilience sub score, which was measured via the percentage of resilience items participants answered correctly, resulting in a maximum PERC score of 4.

CHAPTER 3

Results

Overview of Analyses

Several analyses were conducted to assess the relationship between peer growth mindset and social comparison on participants' learning-related perceptions and behavioral outcomes. First, correlation analyses assessed baseline associations between participants' pre-existing mindsets, learning-related outcomes, and general social comparison tendencies. Next, in accordance with this study's experimental design, a randomization check was conducted to confirm equivalence across groups. Subsequently, a manipulation check was conducted to assess the effectiveness of the social comparison experimental manipulation. Finally, a series of ANCOVA and three mediation models were conducted to test the research hypotheses. ANCOVA models examined group differences in the learning-related outcome variables. After assessing group differences, path analysis mediation models with nested model comparison then tested potential mechanisms of the manipulation effects on their predicted outcomes. All correlation and ANCOVA models were conducted using IBM SPSS, and the mediation path models were conducted using Mplus Version 8.7 (Muthén & Muthén, 1998- 2017).

Pre-Existing Growth Mindset and Social Comparison Associations with Learning-Related Outcomes

Prior to the manipulation, participants reported on their pre-existing growth mindset endorsement, learning-related outcomes, and social comparison tendency. Descriptive statistics for these pre-manipulation measures are shown in Table 1. Consistent with hypotheses, participants' growth mindset endorsement was positively associated with nearly all learning-related outcomes, including perceptions of academic competence ($r = .29$, $p < .01$), learning goals ($r = .27$, $p < .01$), and challenge-seeking ($r = .30$, $p < .01$). However, in contrast to past literature, growth mindset was not associated with self-reported effort, ($r = .05$, *ns*). Social comparison tendency was positively associated with both learning goals ($r = .25$, $p < .01$) and performance goals ($r = .25$, $p < .01$).

Table 1

Correlations and Descriptive Statistics for Growth Mindset, Learning-Related Outcomes, and Social Comparison Tendency Prior to the Manipulation

Variables	1	2	3	4	5	6	7
1. Growth Mindset	-						
2. Academic Competence	.29**	-					
3. Learning Goals	.27**	.33**	-				
4. Performance Goals	.19*	.45**	.59**	-			
5. Challenge-Seeking	.30**	.41**	.49**	.27**	-		
6. Effort	.05	.28**	.39**	.38**	.18	-	
7. Social Comparison Tendency	.04	.07	.25**	.25**	.09	.10	-
M	3.71	5.15	5.38	5.95	3.58	5.81	3.49
SD	0.81	1.12	1.56	1.35	1.73	1.00	0.66

Note. *$p < .05$. **$p < .01$, two-tailed.

Randomization Check

A set of one-way analysis of variance (ANOVA) was conducted to check for group differences across the demographic measures and learning-related outcomes assessed prior to the manipulations. These include (1) demographics (i.e., age, gender, race/ethnicity, SES), and (2) reports of attitudes and behaviors (i.e., pre-existing growth mindset, general academic competence, learning and performance goals, challenge-seeking and effort, general social comparison tendency, and expectations of competence at the problem-solving task). Results of the one-way ANOVAs revealed no significant differences across the four groups (see Table 2). These results indicate that the randomization of participants into the 2x2 factorial design (peer growth mindset/control and upward social comparison/control conditions) was effective. As such, any group differences observed after the manipulations could not be attributed to preexisting differences among the participants.

Table 2

Descriptive Statistics and Randomization Tests for Pre-Manipulation Variables by Condition

	Condition											
	Neutral/No Comparison		Neutral/Upward Comparison		Growth/No Comparison		Growth/Upward Comparison					
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*F*	*df*	*p*	η^2
1. Age	12.67	0.76	12.50	0.78	12.87	0.86	12.90	0.85	1.59	3, 116	.196	.039
2. Gender	1.37	0.49	1.50	0.51	1.37	0.56	1.60	0.68	1.22	3, 116	.305	.031
3. Race/Ethnicity	5.07	0.87	4.76	1.38	4.57	1.01	4.70	1.09	1.11	3, 115	.347	.028
4. SES	6.47	1.22	6.43	1.70	6.93	1.51	6.90	1.45	1.00	3, 116	.395	.025
5. Growth Mindset	4.03	0.51	3.64	0.84	3.66	0.81	3.52	0.98	2.22	3, 116	.090	.054
6. Academic Competence	5.10	1.10	5.13	1.16	5.15	1.03	5.22	1.22	0.06	3, 116	.982	.001
7. Learning Goals	5.76	1.24	5.37	1.35	5.30	1.60	5.10	1.94	0.92	3, 116	.433	.023
8. Performance Goals	6.10	1.21	6.13	0.90	5.83	1.44	5.73	1.74	0.63	3, 116	.596	.016
9. Challenge-Seeking	3.80	1.56	3.17	1.78	3.63	1.85	3.70	1.75	0.78	3, 116	.506	.020
10. Effort	5.60	1.00	5.97	0.93	5.63	1.00	6.03	1.07	1.50	3, 116	.219	.037
11. SC Tendency	3.53	0.62	3.56	0.65	3.43	0.72	3.45	0.68	0.24	3, 116	.870	.006
12. Expectations of Competence at Problem-Solving Task	3.45	0.57	3.52	0.79	3.57	0.67	3.67	0.80	0.51	3, 113	.680	.013

Note. Gender coded as 1 = Female 2 = Male 3 = Other. Race/Ethnicity coded as 1 = American Indian or Alaskan Native 2 = Asian or Pacific Islander 3 = Black 4 = Hispanic/Latinx 5 = White 6 = Multiracial. SC refers to social comparison.

Manipulation Check

The present study included two manipulations, the first involving purported peer growth mindset or neutral statements, and the second involving an upward social comparison or neutral comparison experience. Although the peer growth mindset manipulation was not tested for effectiveness, the manipulation survey included a timer so that participants could not advance to the next screen until they listened to all of the statements. The statements were also included in typed speech bubbles next to each avatar so that participants both heard and read the statements. This ensured that participants received the manipulated statements. In the upward social comparison condition, participants were led to believe they had performed more poorly than their peers on the problem-solving task, while in the neutral condition, they were led to believe they had performed equally as well as their peers. To assess the effectiveness of this second manipulation, a one-way ANOVA was conducted to check for group differences in participants' self-reported perceptions of their and their peers' competence after completing the first problem-solving task. As expected, the results showed significant differences between groups on perceptions of self versus peer competence $F(3, 115) = 191.19$, $p < .001$ (see Table 3). Post hoc analyses indicated that participants in the upward social comparison condition rated their own performance significantly lower than their peers' performance compared to participants in the neutral comparison condition, regardless of peer growth mindset condition. This indicates that the upward social comparison manipulation was effective.

Table 3

Manipulation Check of Perceptions of Competence by Condition

	Condition											
	Neutral/No Comparison		Neutral/Upward Comparison		Growth/No Comparison		Growth/Upward Comparison					
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*F*	*df*	*p*	η^2
1. Perceptions of Competence at Problem-Solving Task	3.85_a	0.49	1.53_b	0.66	3.92_a	0.48	1.49_b	0.51	191.19	3, 115	.000	.833

Note. Perceptions of competence measure administered directly after social comparison manipulation, prior to second problem-solving task. Different letter subscripts indicate a significant difference at $p < .01$.

Effects of Peer Growth Mindset and Social Comparison on Learning-Related Outcomes

To address Hypothesis 1, that peer growth mindset endorsement would predict increased participant growth mindset and its associated learning outcomes, a series of Analysis of Covariance (ANCOVAs) was conducted to examine the effects of the peer growth mindset manipulation on participants' learning-related perceptions and behaviors. All models included age, gender, race/ethnicity, SES, pre-existing growth mindset, and pre-existing social comparison tendency as covariates. Contrary to expectations, results of the ANCOVAs revealed no significant effect of peer growth mindset condition on participants' change in growth mindset, $F(1, 109) = 0.01$, $p = .935$. Participants in both the peer growth mindset and the neutral condition endorsed growth mindset statements to a similar extent ($M = 3.90$, $SD = 0.69$ and $M = 4.05$, $SD = 0.59$, respectively). However, consistent with hypotheses, there were significant effects of peer growth mindset condition on several learning-related perceptions and outcomes. Regarding perceptions, there were significant effects of peer growth mindset condition on upward identification, $F(1, 109) = 10.91$, $p = .001$ (see Table 4, Figure 3), perceptions of self-competence, $F(1, 109) = 7.39$, $p = .008$ (see Table 5, Figure 4), and perceptions of peers' competence, $F(1, 109) = 5.00$, $p = .027$. Participants who heard growth mindset statements from their peers showed increased identification with peers who outperformed them compared to participants who heard neutral statements, and also showed increased perceptions of their own and their peers' competence at the problem-solving task. Regarding self-reported learning outcomes, there were significant effects of growth mindset condition on task

value, $F(1, 109) = 4.48$, $p = .037$ (see Table 6, Figure 5), and self-regulated learning, $F(1, 109) = 4.07$, $p = .046$ (see Table 7, Figure 6), such that participants in the peer growth mindset condition reported increased task value and use of self-regulated learning strategies. Furthermore, in examining the effects of peer growth mindset on participants' objective performance on the post-manipulation problem-solving task, results revealed a significant main effect of peer growth mindset condition on mastery behaviors, $F(1, 109) = 4.92$, $p = .029$ (see Table 8, Figure 7). This indicates that, compared to participants in the neutral mindset condition, participants in the growth mindset condition displayed increased persistence, effort, resilience, and challenge-seeking behaviors.

Table 4

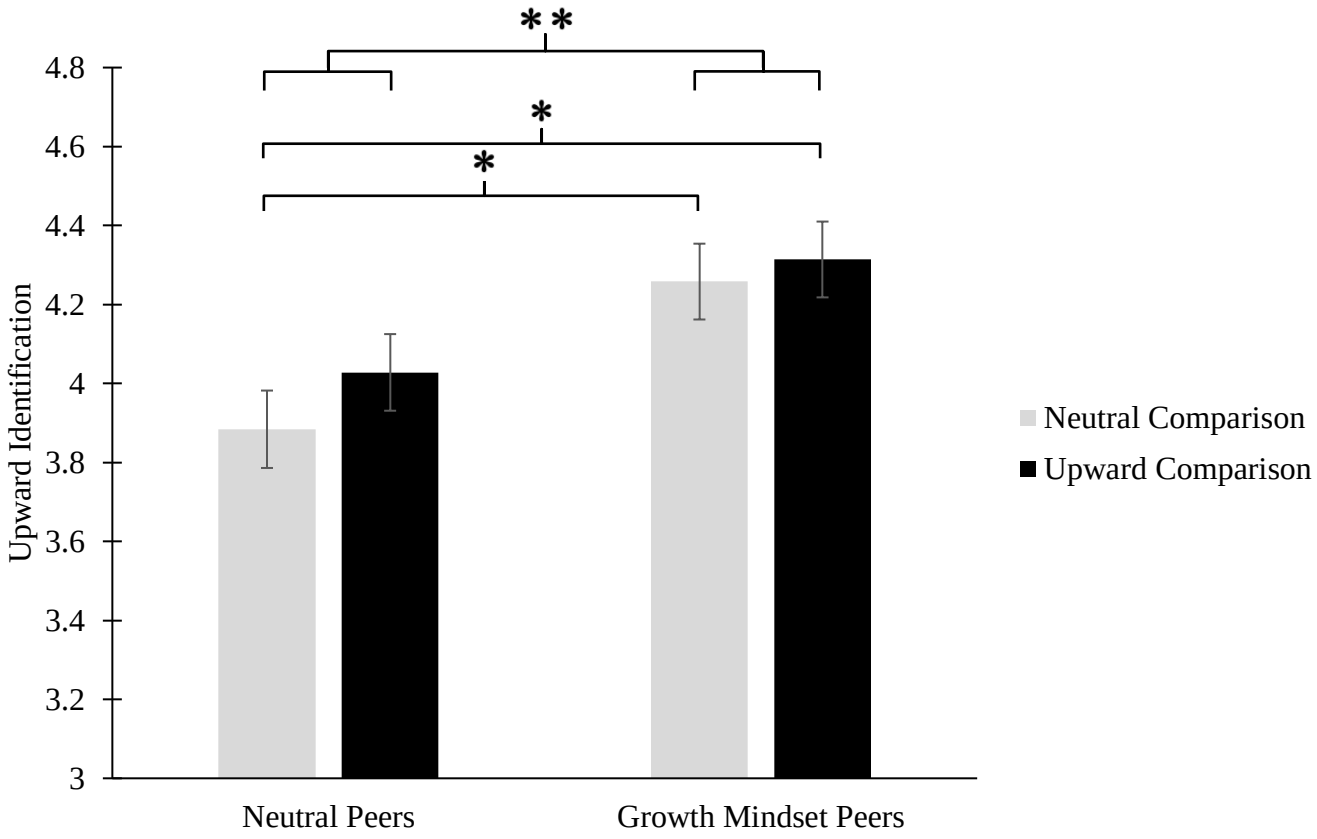
Peer Growth Mindset and Social Comparison Effects on Upward Identification

	F	*df*	*p*	η^2
Predictors				
GM Condition	10.91	1, 109	.001	.091
SC Condition	1.05	1, 109	.309	.010
GM x SC Condition	0.21	1, 109	.646	.002
Covariates				
Age	3.55	1, 109	.062	.032
Gender	0.09	1, 109	.766	.001
Race/Ethnicity	0.39	1, 109	.535	.004
SES	1.95	1, 109	.165	.018
Pre-existing GM	14.03	1, 109	.000	.114
Pre-existing SC	3.65	1, 109	.059	.032

Note. Age, gender, race/ethnicity, socioeconomic status (SES), pre-existing growth mindset (GM) and pre-existing social comparison (SC) included as covariates.

Figure 3

Upward Identification with Peers by GM and SC Condition



Note. Means adjusted for age, gender, race/ethnicity, SES, pre-existing growth mindset and pre-existing social comparison tendency. Error bars represent ± one standard error. *$p < .05$, **$p < .01$.

Table 5

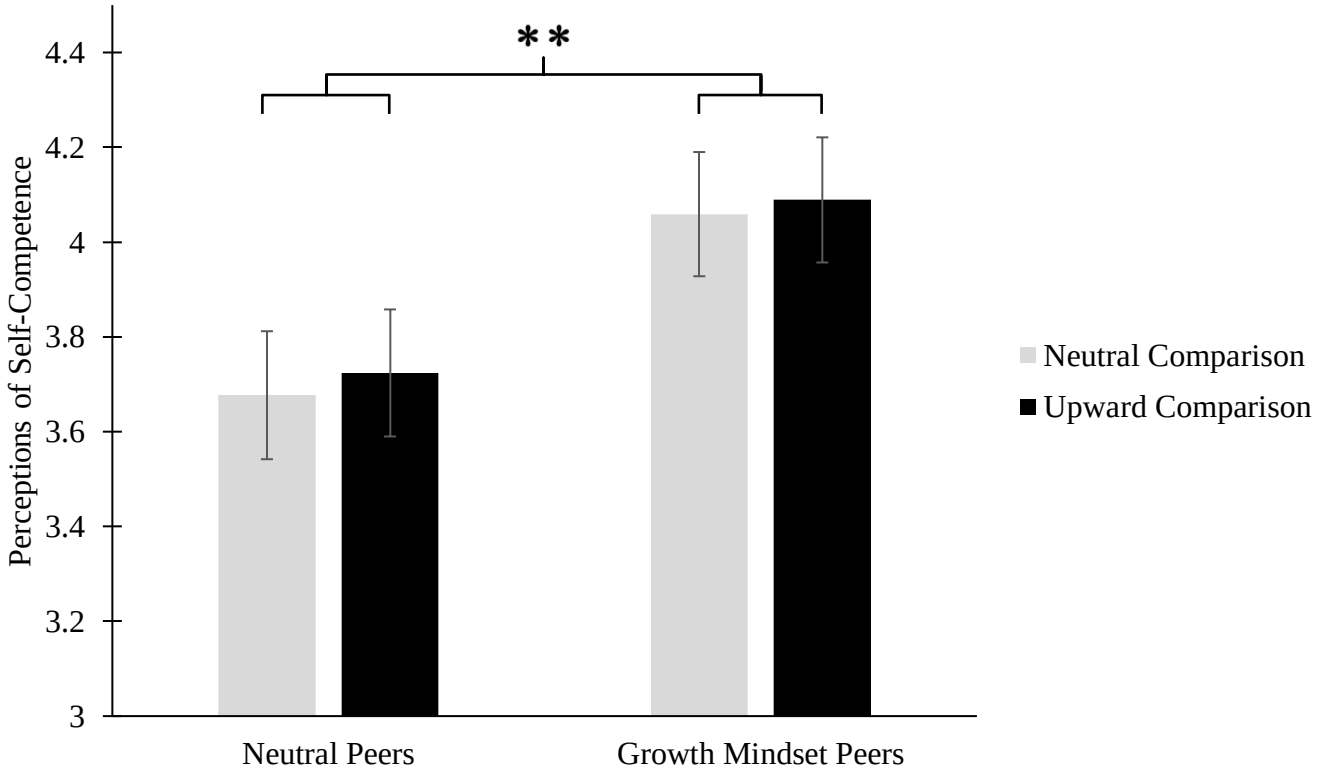
Peer Growth Mindset and Social Comparison Effects on Perceptions of Self-Competence

	F	*df*	*p*	η^2
Predictors				
GM Condition	7.39	1, 109	.008	.064
SC Condition	0.08	1, 109	.777	.001
GM x SC Condition	0.00	1, 109	.949	.000
Covariates				
Age	0.94	1, 109	.336	.009
Gender	0.97	1, 109	.326	.009
Race/Ethnicity	0.02	1, 109	.885	.000
SES	0.00	1, 109	.971	.000
Pre-existing GM	8.55	1, 109	.004	.073
Pre-existing SC	2.29	1, 109	.134	.021

Note. Age, gender, race/ethnicity, socioeconomic status (SES), pre-existing growth mindset (GM) and pre-existing social comparison tendency (SC) included as covariates.

Figure 4

Perceptions of Self-Competence by GM and SC Condition



Note. Means adjusted for age, gender, race/ethnicity, SES, pre-existing growth mindset and pre-existing social comparison tendency. Error bars represent ± one standard error. ***p* < .01.

Table 6

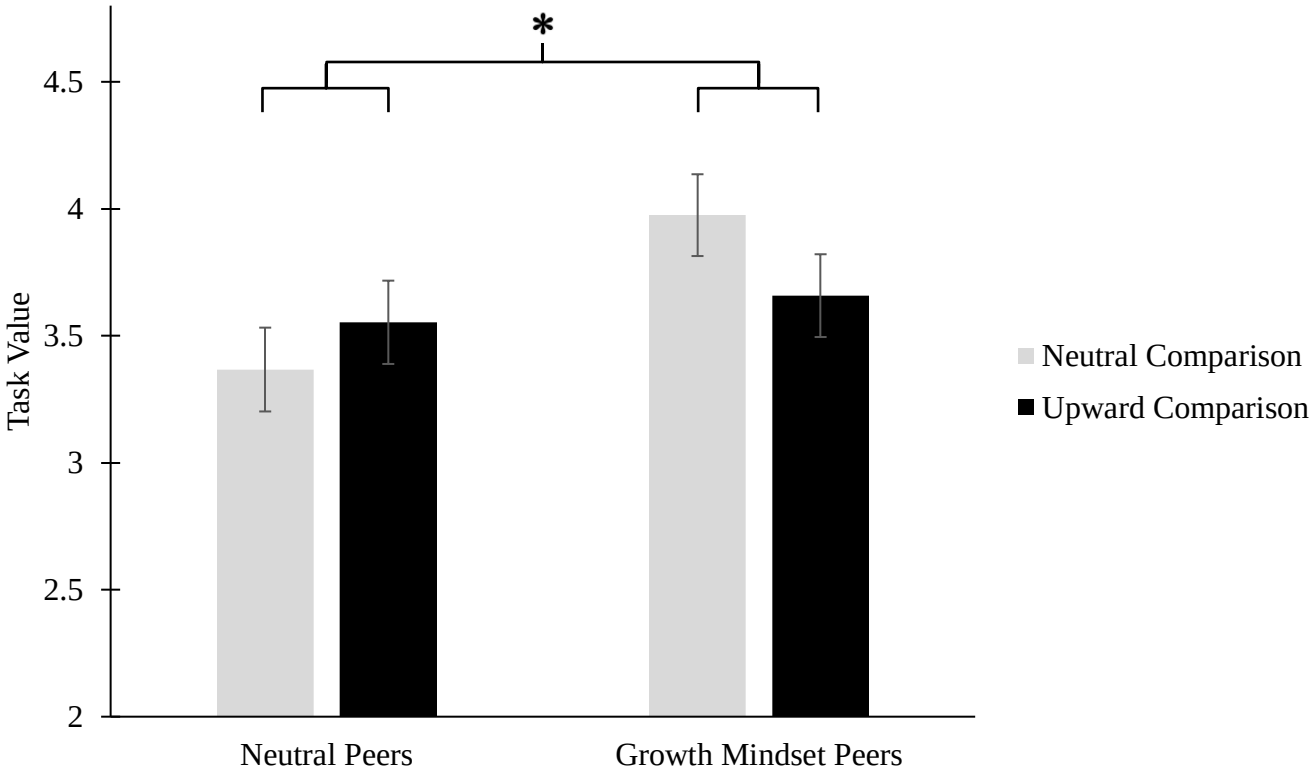
Peer Growth Mindset and Social Comparison Effects on Task Value

	F	*df*	*p*	η^2
Predictors				
GM Condition	4.48	1, 109	.037	.039
SC Condition	0.16	1, 109	.690	.001
GM x SC Condition	2.46	1, 109	.120	.022
Covariates				
Age	0.42	1, 109	.519	.004
Gender	2.74	1, 109	.101	.025
Race/Ethnicity	0.05	1, 109	.828	.000
SES	0.28	1, 109	.597	.003
Pre-existing GM	0.43	1, 109	.513	.004
Pre-existing SC	4.87	1, 109	.029	.043

Note. Age, gender, race/ethnicity, socioeconomic status (SES), pre-existing growth mindset (GM) and pre-existing social comparison tendency (SC) included as covariates.

Figure 5

Task Value by GM and SC Condition



Note. Means adjusted for age, gender, race/ethnicity, SES, pre-existing growth mindset and pre-existing social comparison tendency. Error bars represent ± one standard error. *$p < .05$.

Table 7

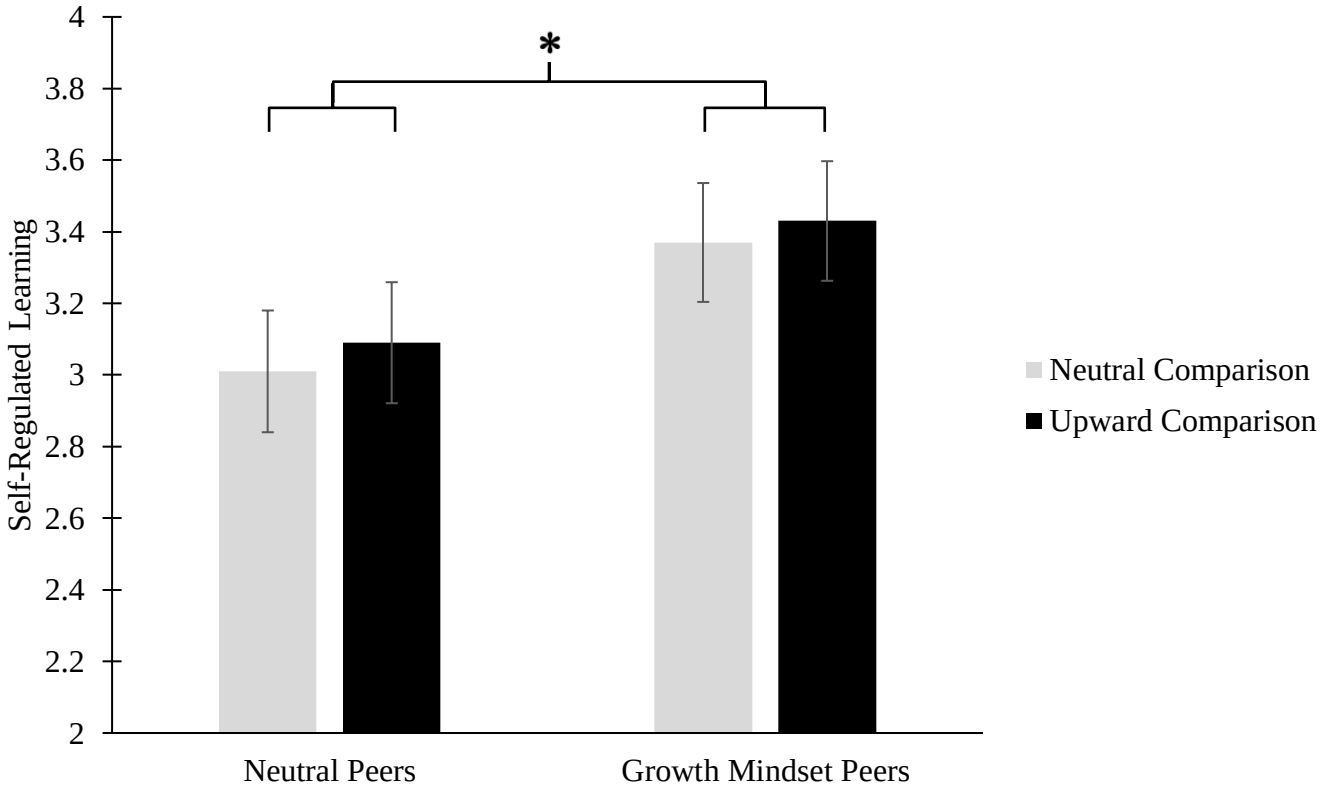
Peer Growth Mindset and Social Comparison Effects on Self-Regulated Learning

	F	*df*	*p*	η^2
Predictors				
GM Condition	4.07	1, 109	.046	.036
SC Condition	0.16	1, 109	.686	.002
GM x SC Condition	0.00	1, 109	.956	.000
Covariates				
Age	0.52	1, 109	.473	.005
Gender	0.76	1, 109	.386	.007
Race/Ethnicity	0.00	1, 109	.974	.000
SES	0.12	1, 109	.733	.001
Pre-existing GM	0.12	1, 109	.732	.001
Pre-existing SC	6.16	1, 109	.015	.053

Note. Age, gender, race/ethnicity, socioeconomic status (SES), pre-existing growth mindset (GM) and pre-existing social comparison tendency (SC) included as covariates.

Figure 6

Self-Regulated Learning by GM and SC Condition



Note. Means adjusted for age, gender, race/ethnicity, SES, pre-existing growth mindset and pre-existing social comparison tendency. Error bars represent ± one standard error. *$p < .05$.

Table 8

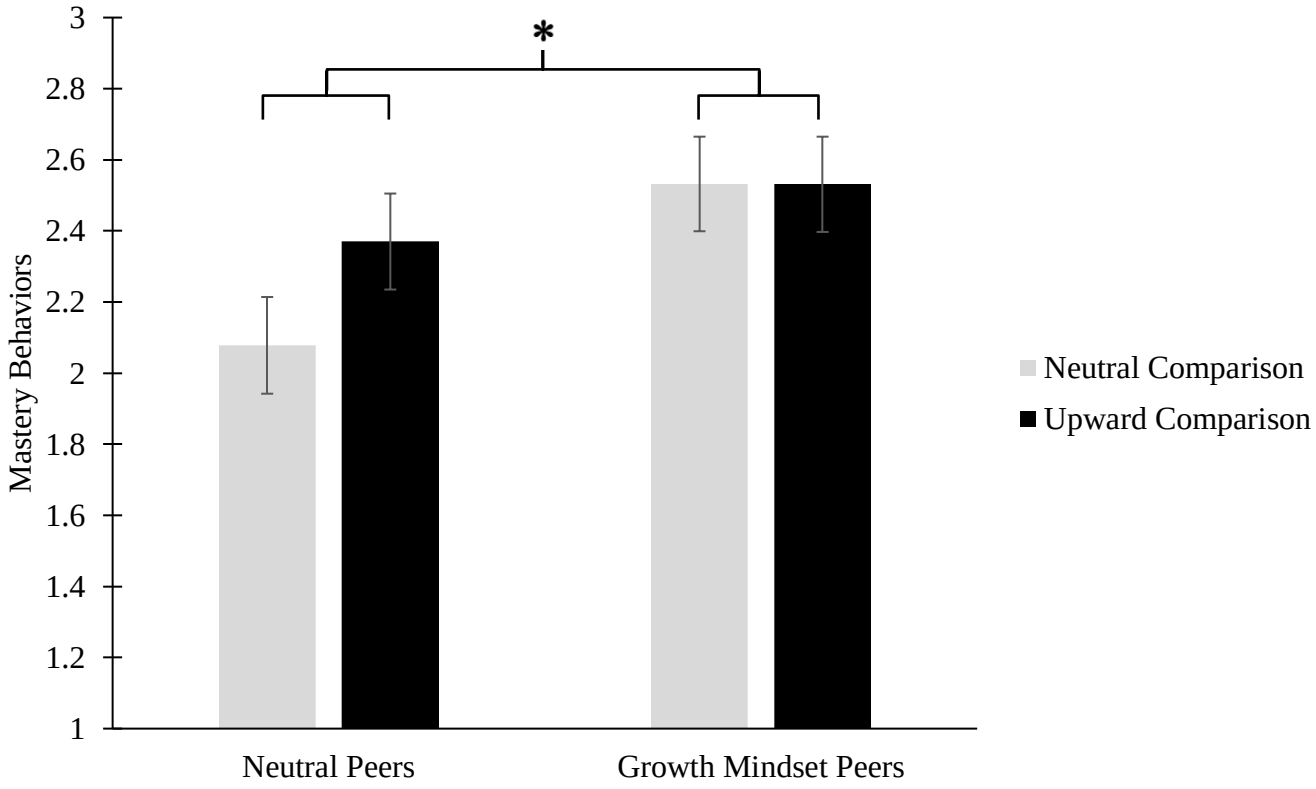
Peer Growth Mindset and Social Comparison Effects on Mastery Behaviors

	F	*df*	*p*	η^2
Predictors				
GM Condition	4.92	1, 109	.029	.043
SC Condition	1.16	1, 109	.284	.011
GM x SC Condition	1.23	1, 109	.270	.011
Covariates				
Age	2.31	1, 109	.131	.021
Gender	2.54	1, 109	.114	.023
Race/Ethnicity	5.01	1, 109	.027	.044
SES	1.61	1, 109	.207	.015
Pre-existing GM	13.97	1, 109	.000	.114
Pre-existing SC	0.08	1, 109	.782	.001

Note. Age, gender, race/ethnicity, socioeconomic status (SES), pre-existing growth mindset (GM) and pre-existing social comparison tendency (SC) included as covariates.

Figure 7

Mastery Behaviors by GM and SC Condition



Note. Means adjusted for age, gender, race/ethnicity, SES, pre-existing growth mindset and pre-existing social comparison tendency. Error bars represent ± one standard error. *$p < .05$.

To address Hypothesis 2, that the social comparison manipulation would result in negative learning-related consequences, ANCOVA models examined the effects of the social comparison manipulation on learning-related outcomes As expected, there was a significant main effect of social comparison condition on upward contrast, $F(1, 109) = 4.54$, $p = .035$ (see Table 9, Figure 8), such that participants in the upward social comparison condition reported increased upward contrast with peers compared to participants in the neutral social comparison condition. As was found with the growth mindset manipulation, there was also a significant main effect of the social comparison manipulation on perceptions of peers' competence, $F(1, 109) = 4.89$, $p = .029$, such that participants in the upward comparison conditions believed their peers to be more competent and capable of performing well at the problem-solving task (see Table 10, Figure 9).

Hypothesis 3 predicted that there would be an interaction of the peer growth mindset and social comparison conditions on participants learning outcomes and self-perceptions, such that peer growth mindset might dampen the negative consequences of social comparison and increase positive outcomes. This was tested by assessing the interaction terms in the ANCOVA models detailed above for all outcome variables, including identification/contrast, self- and peers' competence perceptions, task effort, task value, learning goals, self-regulated learning, task anxiety, mastery behaviors, and performance on the Raven's Matrices task. Contrary to hypotheses, no significant interactions between peer growth mindset condition and social comparison condition were found. This indicates that peer growth mindset condition did not lessen or

strengthen the effects of the social comparison manipulation on participants' self-perceptions and learning-related outcomes.

Table 9

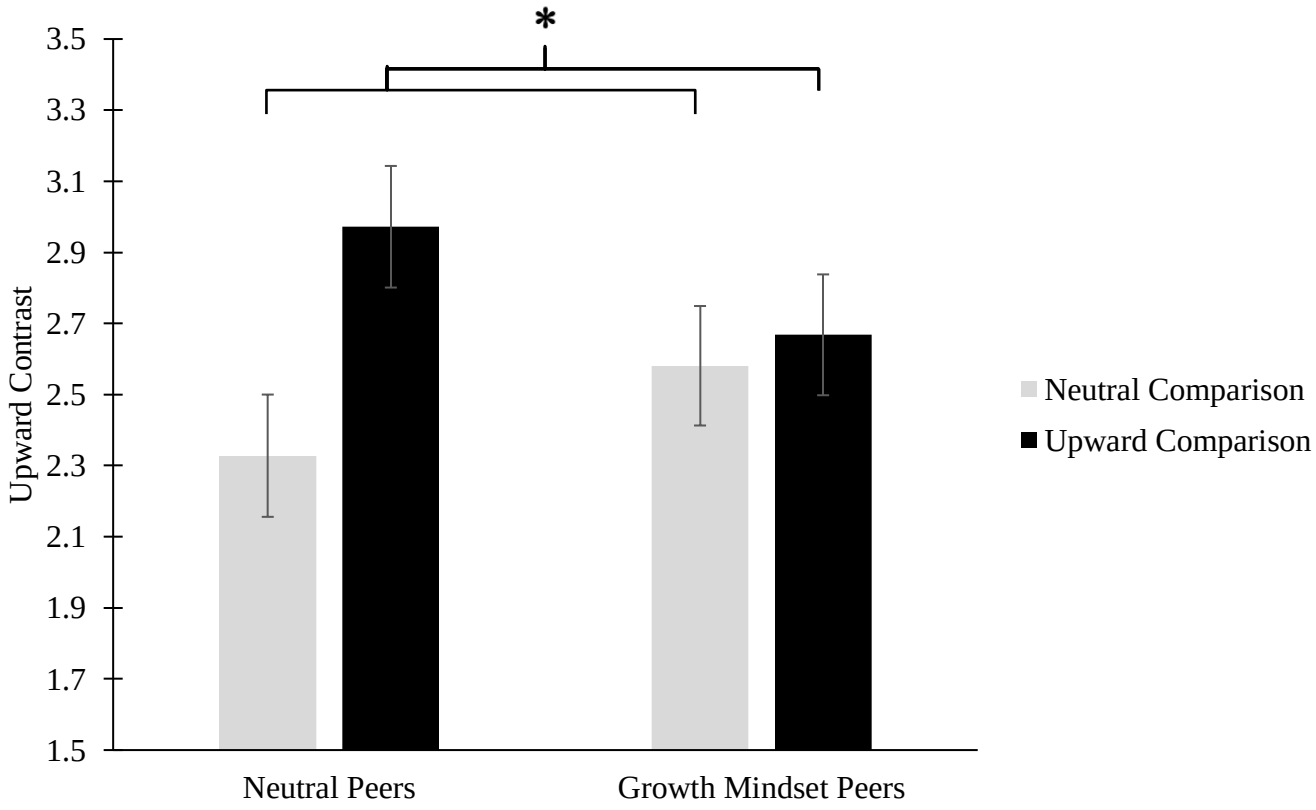
Peer Growth Mindset and Social Comparison Effects on Upward Contrast

	F	*df*	*p*	η^2
Predictors				
GM Condition	0.02	1, 109	.882	.000
SC Condition	4.54	1, 109	.035	.040
GM x SC Condition	2.76	1, 109	.100	.025
Covariates				
Age	1.28	1, 109	.261	.012
Gender	0.26	1, 109	.613	.002
Race/Ethnicity	0.37	1, 109	.543	.003
SES	0.52	1, 109	.820	.000
Pre-existing GM	0.37	1, 109	.543	.003
Pre-existing SC	1.41	1, 109	.238	.013

Note. Age, gender, race/ethnicity, socioeconomic status (SES), pre-existing growth mindset (GM) and pre-existing social comparison (SC) included as covariates. *$p < .05$, **$p < .01$.

Figure 8

Upward Contrast with Peers by GM and SC Condition



Note. Means adjusted for age, gender, race/ethnicity, SES, pre-existing growth mindset and pre-existing social comparison tendency. Error bars represent ± one standard error. *$p < .05$, **$p < .01$.

Table 10

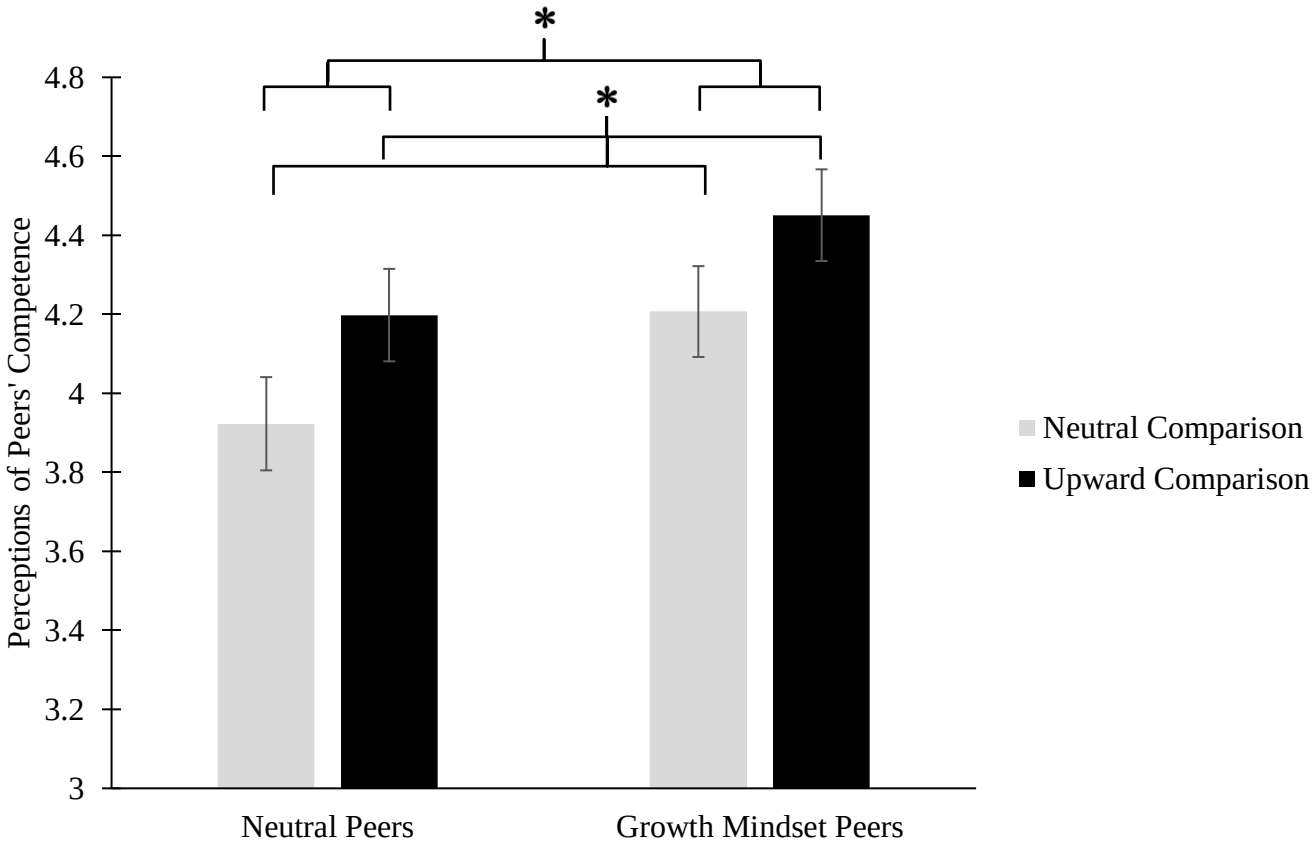
Peer Growth Mindset and Social Comparison Effects on Perceptions of Peers' Competence

Predictor	*F*	*df*	*p*	η^2
GM Condition	5.00	1, 109	.027	.044
SC Condition	4.89	1, 109	.029	.043
GM x SC Condition	0.02	1, 109	.894	.000
Age	0.00	1, 109	.999	.000
Gender	0.00	1, 109	.961	.000
Race/Ethnicity	0.10	1, 109	.756	.001
SES	0.60	1, 109	.439	.006
Pre-existing GM	8.55	1, 109	.004	.073
Pre-existing SC	2.69	1, 109	.104	.024

Note. Age, gender, race/ethnicity, socioeconomic status (SES), pre-existing growth mindset (GM) and pre-existing social comparison (SC) included as covariates.

Figure 9

Perceptions of Peers' Competence by GM and SC Condition



Note. Means adjusted for age, gender, race/ethnicity, SES, pre-existing growth mindset and pre-existing social comparison tendency. Error bars represent ± one standard error. *$p < .05$, **$p < .01$.

Other Effects of Peer Growth Mindset and Social Comparison on Learning-Related Outcomes

In addition to the above outcome variables, several other motivation and learning-related outcome variables were analyzed to examine the effect of the growth mindset and social comparison manipulations. Contrary to hypotheses, no effect of peer growth mindset, $F(1, 109) = 2.63$, $p = .108$ or social comparison condition, $F(1, 109) = 0.31$, $p = .580$ was found for participant self-reported task effort. Similarly, no effect of peer growth mindset, $F(1, 108) = 2.33$, $p = .130$ or social comparison condition, $F(1, 108) = 0.28$, $p = .599$ was found for learning goals. It was expected that objective performance on the second problem-solving task may be affected by the manipulations, but no effect of peer growth mindset, $F(1, 109) = 2.09$, $p = .151$ or social comparison condition, $F(1, 109) = 0.74$, $p = .392$, was found. It was also expected that anxiety regarding the problem-solving task may be affected by the manipulations, but no effect of peer growth mindset, $F(1, 109) = 0.00$, $p = .962$, or social comparison condition, $F(1, 109) = 0.93$, $p = .337$, was found. As with the peer growth mindset condition, there was also no effect of or social comparison condition, $F(1, 109) = 2.54$, $p = .114$ on participants' change in growth mindset endorsement. A summary of significant main effects for both manipulations is shown in Table 11.

Table 11

Peer Growth Mindset and Social Comparison Effects Summary

	Significant Main Effect	
Outcome	GM Condition	SC Condition
Beliefs and Perceptions		
Change in GM	X	X
Upward Identification	√	X
Upward Contrast	X	√
Perceptions of Self-Competence	√	X
Perceptions of Peers' Competence	√	√
Task Effort	X	X
Task Value	√	X
Learning Goals	X	X
Self-Regulated Learning	√	X
Task Anxiety	X	X
Objective Behaviors		
Mastery Behaviors	√	X
Raven's Matrices Performance	X	X

Note. Green check marks represent significant main effects at $p < .05$. Age, gender, race/ethnicity, socioeconomic status (SES), pre-existing growth mindset (GM) and pre-existing social comparison (SC) included as covariates.

Mechanisms of Peer Growth Mindset Influence on Learning-Related Outcomes

Hypothesis 4 predicted a replication of prior research demonstrating that perceptions of peers' competence mediated the relationship between peer growth mindset and learning-related outcomes (Sheffler & Cheung, 2020). It was also predicted that identification with higher performing peers would explain the relationship between peer growth mindset and learning-related outcomes. As such, this set of analyses tested the role of perceptions of peers' competence and upward identification as viable mechanisms underlying the association between peer growth mindset and learning outcomes. The mediation models were evaluated in the context of path analysis using Mplus Version 8.7 (Muthén & Muthén, 1998-2017). A total of 3 models was evaluated. The first model tested perceptions of peers' competence as a mechanism underlying the association between peer growth mindset and learning-related outcomes, which included all outcomes that were influenced by the growth mindset manipulation (apart from the suspected mediation variables): perceptions of self-competence, self-regulated learning strategies, task value, and mastery behaviors. All models included age, gender, race/ethnicity, SES, pre-existing growth mindset, and pre-existing social comparison tendency as covariates. Both gender and race/ethnicity were dummy-coded prior to their inclusion in the models, as is necessary for nominal data (Lyons, 1971). To minimize the number of covariates in the model, gender and race/ethnicity were coded as single dummy coded variables, with gender coded as: 1= female, 0 = male. Non-binary and genderfluid participants (n = 4) were excluded due to low frequencies. Race/ethnicity were coded as 1 = underrepresented minority status (including all American Indian or

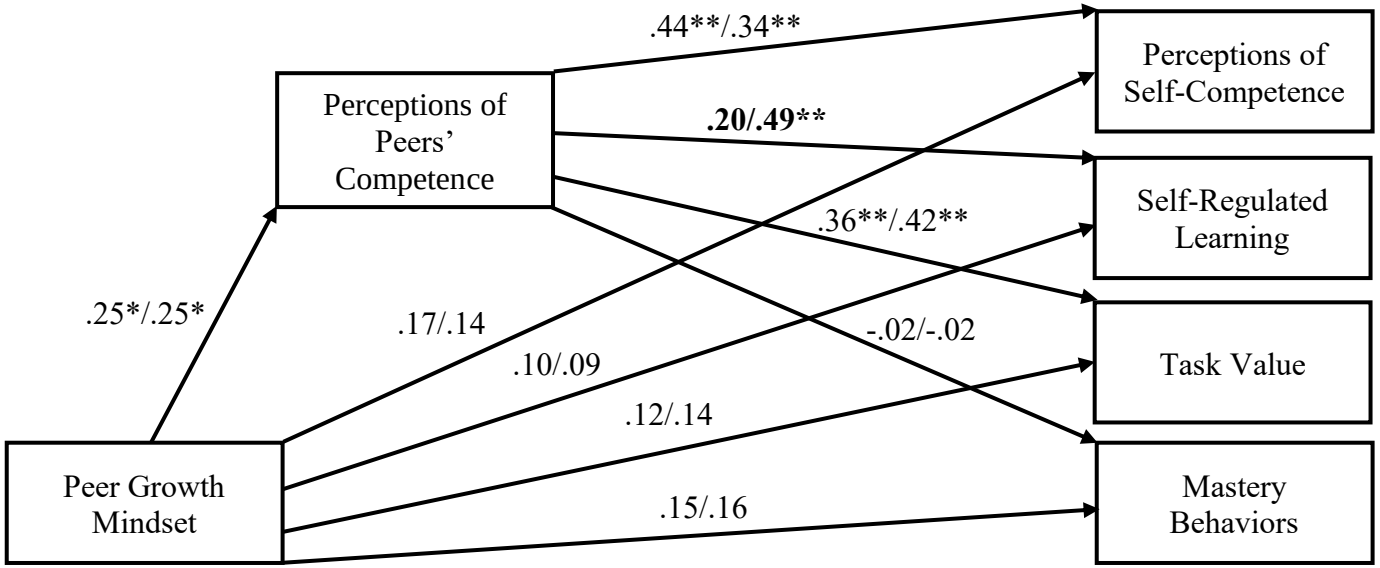
Alaskan Native, Black, and Hispanic/Latinx participants) and 0 = non-underrepresented minority status (including all White participants; Carter, 2006). Asian or Pacific Islander participants (n = 2) were excluded due to lack of specific information regarding their group membership. This dummy coding system was selected in order to minimize the number of covariates in the models while retaining as much information as possible. Separate models were assessed for each of the two mediators (i.e., perceptions of peers' competence and identification with peers) as well as a combined model with both mediators. Nested model comparison was employed to determine whether mediation effects differed between the social comparison conditions.

The first mediation model assessed the role of perceptions of peers' competence as a viable mechanism (see Figure 10). The Indirect command in Mplus with bootstrap estimation of 1000 samples (Shrout & Bolger, 2002) was used to assess direct, indirect, and total effects with 95% confidence intervals. Delta tests of indirect effects were conducted to determine whether the associations between peer growth mindset and learning-related outcomes were explained by perceptions of peers' competence. Replicating past research (Sheffler & Cheung, 2020), results revealed that perceptions of peers' competence was a significant mediator in the relationship between peer growth mindset condition and task value (see Table 12). When perceptions of peers' competence was added to the model, the association between peer growth mindset and task value and the other outcome variables were reduced. The indirect effects of peer growth mindset on task value (upward comparison condition only, marginal effect for neutral comparison condition, z = 1.92, p = .055), perceptions of self-competence, and self-regulated learning

(upward comparison condition only) via perceptions of peers' competence were significant, z's = 2.00 to 2.13, p's = .033 to .046.

Figure 10

Perceptions of Peers' Competence Partially Mediated the Associations Between Peer Growth Mindset and Learning-Related Outcomes



Note. Standardized regression coefficients for the relationship between peer mindset condition and learning-related outcomes as mediated by perceptions of peers' competence. Estimates for both social comparison conditions were presented (neutral comparison condition/upward comparison condition). Boldface indicates an unconstrained path with a significant difference between the neutral and upward comparison conditions. All other paths did not differ across conditions and were constrained in the final model. Model adjusted for age, gender, race/ethnicity, SES, pre-existing growth mindset and pre-existing social comparison tendency. *$p < .05$, **$p < .01$.

Table 12

Total, Direct, and Indirect Effects for Mediation Model of Perceptions of Peers' Competence

Effect			95% CI	
	Estimate	*SE*	Lower	Upper
Peer GM Predicting Self-Competence				
Total Effect	.28/.22	.14/.11	.02/.01	.55/.45
Direct Effect	.17/.14	.13/.10	-.06/-.05	.44/.35
Indirect Effect				
Peer GM Condition→ Perceptions of PC→ Self-Competence	.11/.09	.05/.04	.02/.02	.22/.18
Peer GM Predicting SRL				
Total Effect	.15/.21	.12/.11	-.08/-.02	.37/.41
Direct Effect	.10/.09	.11/.10	-.13/-.11	.32/.28
Indirect Effect				
Peer GM Condition→ Perceptions of PC→ SRL	.05/.12	.04/.06	-.00/.02	.16/.26
Peer GM Predicting Task Value				
Total Effect	.21/.24	.11/.12	-.02/-.01	.41/.44
Direct Effect	.12/.14	.11/.11	-.10/-.09	.32/.35
Indirect Effect				
Peer GM Condition→ Perceptions of PC→ Task Value	.09/.11	.05/.05	.01/.02	.20/.24
Peer GM Predicting Mastery Behaviors				
Total Effect	.14/.15	.10/.11	-.06/-.09	.32/.33
Direct Effect	.15/.16	.10/.11	-.07/-.09	.33/.36
Indirect Effect				
Peer GM Condition→ Perceptions of PC→ Mastery Behaviors	-.00/-.01	.03/.03	-.07/-.07	.04/.05

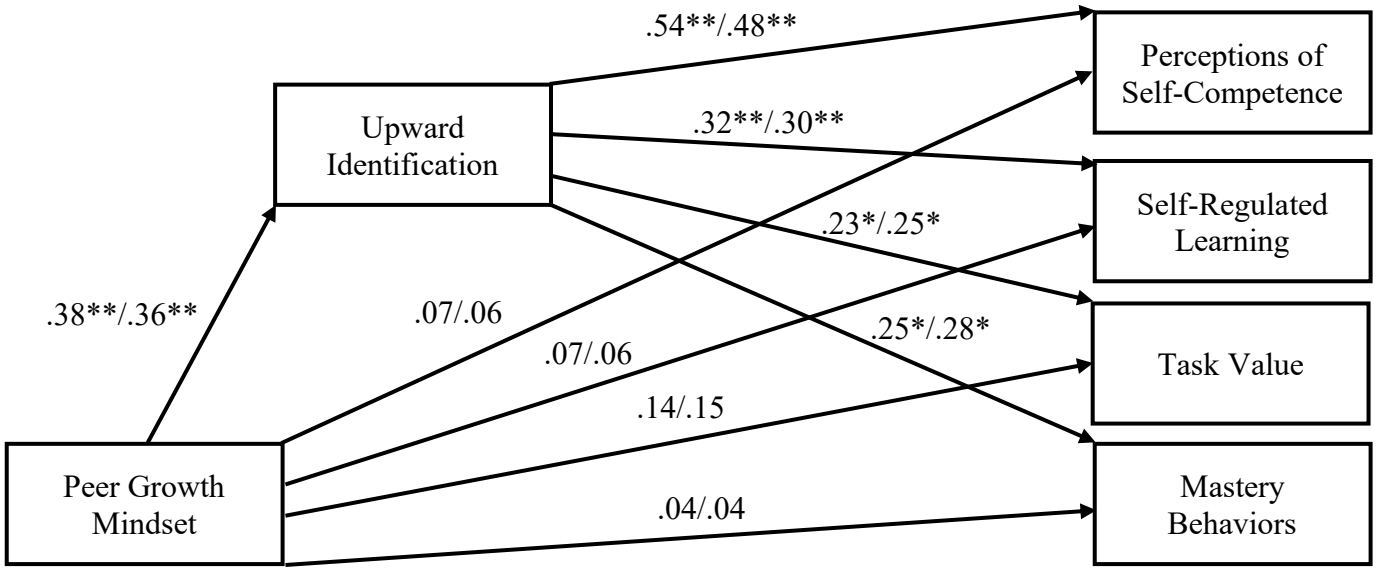
Note. Standardized coefficients reported for neutral social comparison/upward social comparison conditions. GM refers to growth mindset, PC refers to peers' competence, SRL refers to self-regulated learning. CI's that do not cross zero indicate marginal and significant effects.

Nested model comparison tested whether the mediation effects differed between the two social comparison conditions. The fully unconstrained model was compared to a series of constrained models, in which each set of paths for the neutral and upward comparison conditions was constrained to be equal. Chi-square difference tests indicated that the constrained model fit equally as well as the unconstrained model for all but one path, perceptions of peers' competence → self-regulated learning strategies, $\Delta\chi^2(1) > 3.84$, $p < .05$ (see Appendix M). Thus, this path was allowed to freely vary between the neutral and upward comparison groups, while all other paths were constrained to be equal between groups, in order to achieve the most parsimonious model. The final model had excellent fit, $\chi^2(8) = 5.64$, $p = .688$, RMSEA = 0.00, CFI = 1.00, TLI = 1.00.

A second mediation model assessed identification as a potential mediator (see Figure 11). Consistent with expectations, when identification was added to the model, the associations between peer growth mindset and the outcome variables were reduced. The indirect effect of peer mindset condition through identification was significant for self-competence and for self-regulated learning, *z*'s = 2.25 to 3.23, *p*'s = .001 to .024 (see Table 13). Additionally, there were marginally significant indirect effects for task value and mastery behaviors, *z*'s = 1.83 to 1.94, *p*'s = .052 to .068. As with the first model, this model was also tested for moderation of social comparison condition using nested model comparison. The chi-square difference test indicated no significant differences between the fit of the constrained and unconstrained paths, $\Delta\chi^2(1) < 3.84$, *p*'s ns. This indicates that the model fits equally well in the neutral and upward comparison conditions. As such, all paths were constrained to be equal across social comparison groups to attain the most parsimonious final model. The final model had excellent fit, $\chi^2(9) = 5.48$, $p = .791$, RMSEA = 0.00, CFI = 1.00, TLI = 1.00.

Figure 11

Upward Identification Partially Mediated the Associations Between Peer Growth Mindset and Learning-Related Outcomes



Note. Standardized regression coefficients for the relationship between peer mindset condition and learning-related outcomes as mediated by upward identification. Estimates for both social comparison conditions were presented (neutral comparison condition/upward comparison condition). All paths did not differ between the two conditions and were constrained in the final model. Model adjusted for age, gender, race/ethnicity, SES, pre-existing growth mindset and pre-existing social comparison tendency. *$p < .05$, **$p < .01$.

Table 13

Total, Direct, and Indirect Effects for Mediation Model of Upward Identification

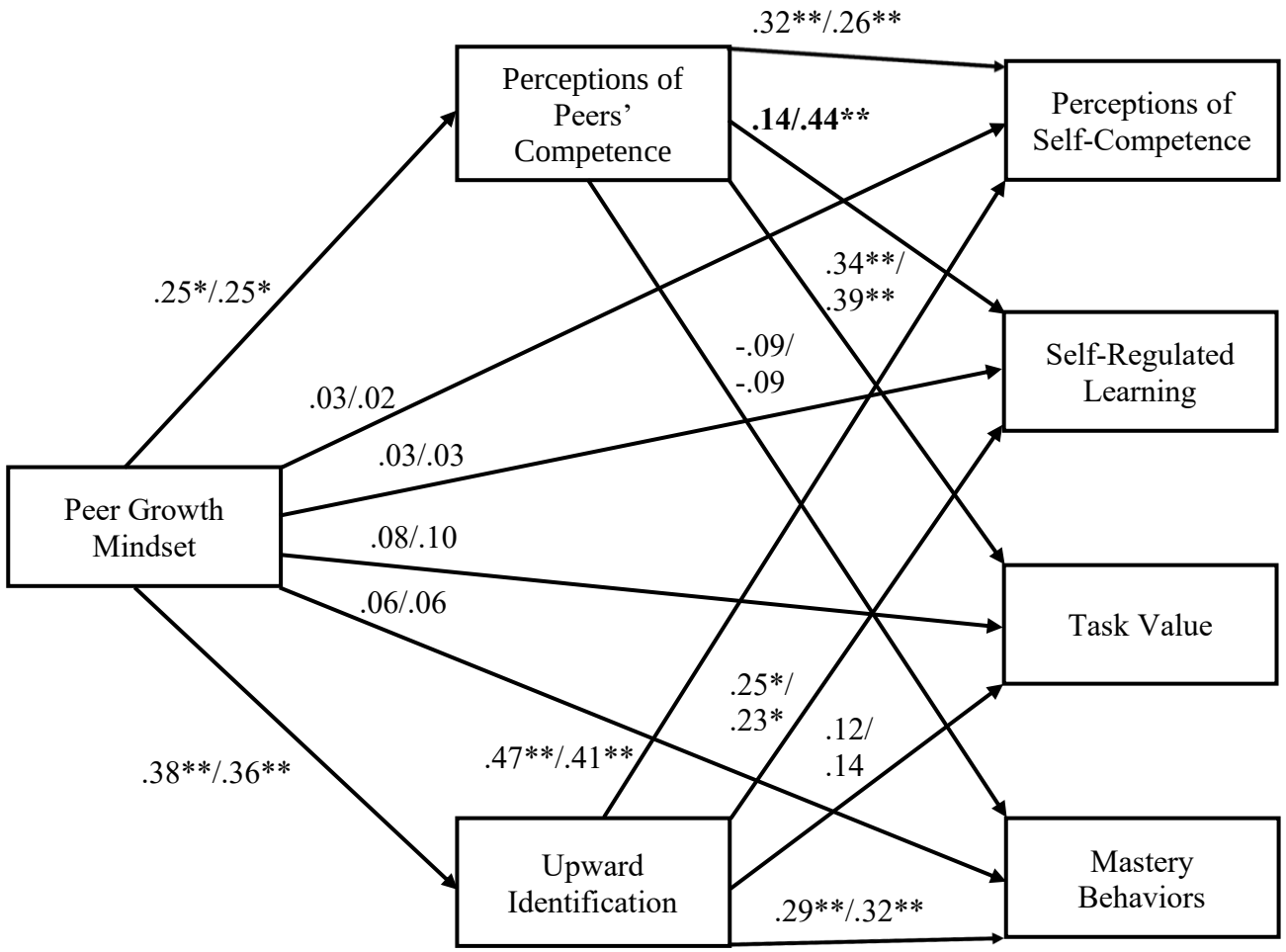
Effect			95% CI	
	Estimate	*SE*	Lower	Upper
Peer GM Predicting Self-Competence				
Total Effect	.27/.23	.13/.11	.03/.02	.53/.45
Direct Effect	.07/.06	.12/.10	-.15/-.12	.33/.28
Indirect Effect				
Peer GM Condition→ Upward Identification→ Self-Competence	.20/.17	.06/.06	.10/.08	.35/.30
Peer GM Predicting SRL				
Total Effect	.20/.17	.12/.10	-.04/-.03	.42/.36
Direct Effect	.07/.06	.11/.09	-.13/-.12	.28/.25
Indirect Effect				
Peer GM Condition→ Upward Identification→ SRL	.12/.11	.06/.05	.04/.03	.24/.22
Peer GM Predicting Task Value				
Total Effect	.23/.24	.11/.11	-.01/-0.00	.44/.43
Direct Effect	.14/.15	.11/.11	-.08/-.07	.36/.36
Indirect Effect				
Peer GM Condition→ Upward Identification→ Task Value	.09/.09	.05/.05	.01/.02	.20/.21
Peer GM Predicting Mastery Behaviors				
Total Effect	.13/.14	.10/.11	-.08/-.10	.31/.32
Direct Effect	.04/.04	.11/.12	-.19/-.21	.24/.26
Indirect Effect				
Peer GM Condition→ Upward Identification→ Mastery Behaviors	.10/.10	.05/.06	.02/.02	.22/.24

Note. Standardized coefficients reported for neutral social comparison/upward social comparison conditions. GM refers to growth mindset, SRL refers to self-regulated learning. CI's that do not cross zero indicate marginal and significant effects.

Lastly, a combined model with both perceptions of peers' competence and identification as mediators was assessed (see Figure 12). As in the first model, when perceptions of peers' competence and identification were included in the model, the associations between peer growth mindset and the outcome variables were reduced. Delta tests indicated that the indirect effect of peer mindset condition through identification was significant for perceptions of self-competence and mastery behaviors, *z*'s = 2.03 to 3.02, *p*'s = .001 to .042 (see Table 14). There was also a marginally significant indirect effect through identification on self-regulated learning strategies, *z's* = 1.87 to 1.88, *p*'s = .060 to .061. With identification added as an additional mediator, the previously significant indirect effects of peer mindset condition through peers' competence on task value, perceptions of self-competence, and self-regulated learning strategies (upward comparison condition only) were reduced to marginally significant, *z's* = 1.84 to 1.90, *p*'s = .057 to .065. Consistent with the perceptions of peers' competence model, nested model comparison to test the moderation of social comparison groups indicated that one path, perceptions of peers' competence → self-regulated learning strategies, was significantly different when constrained compared to when unconstrained, $\Delta\chi^2(1) > 3.84$, $p < .05$. Thus, this path was allowed to freely vary, while all other paths were constrained to be equal across groups for the final model. The final model had good fit, $\chi^2(15) = 16.47$, $p = .352$, RMSEA = 0.04, CFI = 0.99, TLI = 0.94.

Figure 12

Combined Mediation Model



Note. Standardized regression coefficients for the relationship between peer mindset condition and learning-related outcomes as mediated by perceptions of peers' competence and upward identification. Estimates for both social comparison conditions were presented (neutral comparison condition/upward comparison condition). Boldface indicates an unconstrained path with a significant difference between the neutral and upward comparison conditions. All other paths did not differ across conditions and were constrained in the final model. Model adjusted for age, gender, race/ethnicity, SES, pre-existing growth mindset and pre-existing social comparison tendency. *$p < .05$, **$p < .01$.

Table 14

Total, Direct, and Indirect Effects for Mediation Model of Perceptions of Peers' Competence and Upward Identification

Effect			95% CI	
	Estimate	SE	Lower	Upper
Peer GM Predicting Self-Competence				
Total Effect	.28/.24	.13/.11	.04/.02	.54/.46
Direct Effect	.03/.02	.12/.10	-.18/-.16	.30/.24
Indirect Effect				
Peer GM Condition→ Perceptions of PC→ Self-Competence	.08/.07	.04/.04	.02/.01	.18/.15
Peer GM Condition→ Upward Identification→ Self-Competence	.18/.15	.06/.05	.08/.07	.32/.27
Peer GM Predicting Self-Regulated Learning				
Total Effect	.17/.22	.12/.11	-.06/.01	.40/.42
Direct Effect	.03/.03	.11/.10	-.17/-.16	.25/.22
Indirect Effect				
Peer GM Condition→ Perceptions of PC→ SRL	.04/.11	.03/.06	-.01/.02	.13/.26
Peer GM Condition→ Upward Identification→ SRL	.10/.08	.05/.05	.02/.02	.21/.18
Peer GM Predicting Task Value				
Total Effect	.21/.25	.11/.12	-.02/.00	.41/.44
Direct Effect	.08/.10	.11/.12	-.13/-.13	.29/.31
Indirect Effect				
Peer GM Condition→ Perceptions of PC→ Task Value	.08/.10	.04/.05	.01/.02	.19/.23
Peer GM Condition→ Upward Identification→ Task Value	.05/.05	.04/.05	-.02/-.02	.15/.17
Peer GM Predicting Mastery Behaviors				
Total Effect	.15/.16	.09/.10	-.06/-.08	.32/.32
Direct Effect	.06/.06	.10/.11	-.16/-.18	.26/.28
Indirect Effect				
Peer GM Condition→ Perceptions of PC→ Mastery Behaviors	-.02/-.02	.03/.03	-.10/-.10	.02/.03
Peer GM Condition→ Upward Identification→ Mastery Behaviors	.11/.12	.05/.06	.03/.02	.24/.25

Note. Standardized coefficients reported for neutral social comparison/upward social comparison conditions. GM refers to growth mindset, PC refers to peers' competence, SRL refers to self-regulated learning. CI's that do not cross zero indicate marginal and significant effects.

CHAPTER 4

Discussion

This dissertation examined the effects of peer growth mindset and social comparison on middle school-age adolescents' academic perceptions and learning-related outcomes. The 2x2 experimental design applied a novel online paradigm using simulated peer avatars to manipulate participants' beliefs about their peers' growth mindsets and induce a social comparison experience. Although change in participants' growth mindsets was not evident, peer growth mindset condition showed significant effects on several learning-related outcomes, while the social comparison condition affected competence and upward contrast perceptions. No interactions between peer growth mindset and social comparison were found, but, consistent with expectations, two mechanisms underlying the associations between peer growth mindset and learning-related outcomes were identified: perceptions of peers' competence and upward identification with peers.

Pre-Existing Growth Mindset and Learning-Related Outcomes

Preliminary correlation analyses revealed that participants' pre-existing growth mindset was positively associated with multiple learning-related beliefs and behaviors, including perceptions of academic competence, learning goals, and challenge-seeking. These findings align with the image one may conjure of the definitive "growth mindset child" established from past literature: a child who is optimistic about their academic potential, enjoys learning for the sake of learning, and always relishes a challenge (Mueller & Dweck, 1998; Dweck, 2000). Growth mindset also was associated with

performance goals. Although this may seem contradictory to the notion of the growth mindset/learning goal and fixed mindset/performance goal dichotomy, more recent literature has demonstrated that learning and performance goals are not mutually exclusive, nor that performance goals are necessarily detrimental to learning outcomes (Harackiewicz et al., 2002). Furthermore, researchers argue that fixed mindsets may be more predictive of performance-avoidance goals (e.g., doing homework to avoid punishment), rather than performance-approach goals (e.g., doing homework to perform well in the class) (Yeager & Dweck, 2020), and the single item used to measure performance goals was a performance-approach item. Thus, these findings are consistent with past research and provide support for the notion of growth mindset endorsement as a beneficial force in adolescents' motivation and learning.

Interestingly, pre-existing growth mindset was not associated with self-reported effort in school, nor was it associated with pre-existing social comparison tendency. Regarding effort, it may be the case that the results were affected by a social desirability bias. As discussed in the introduction, as children's cognitive capacities change from childhood to adolescence, so too do their perceptions of the relationship between ability and effort (Nicholls, 1978). They begin to view effort as inversely related to ability, and, as such, may consider it a negative characteristic. For this reason, it may be the case that adolescents did not report their effort exertion in school accurately, and may have been more reluctant to report that they invested a lot of effort in school, which would be consistent with a growth mindset. However, it must also be acknowledged that, as with learning goals, performance goals, and challenge-seeking, effort in school was measured

with a single item (How much effort to you put in your schoolwork?), merely to gauge baseline associations. It may be the case that this single item did not accurately capture effort in academics, as participants may have differed in their interpretations of "schoolwork." Anecdotally, to illustrate this potential confusion, during one session a participant asked about this measure, whether it applied to homework, and, when told it applied to all school-related work, replied "We don't really have homework." Thus, a greater variety of items may have better captured this construct.

Pre-existing growth mindset also was not associated with pre-existing social comparison tendency. While there were no specific hypotheses regarding this construct, the complete lack of a relationship was surprising, given that social comparison tendency was associated with learning and performance goals, and, like growth mindset, is implicated in students' achievement and motivation (Altermatt & Pomerantz, 2005; Raat et al., 2013). However, unlike growth mindset endorsement, which has consistent, positive effects on achievement, social comparison's effects are mixed, and often contingent on the type of comparison that is utilized, with growth mindset predicting increased upward social comparison for self-improvement purposes, and fixed mindset predicting increased downward social comparison for self-esteem repair purposes (Nussbaum & Dweck, 2008). The measure used to assess pre-existing social comparison tendency was more general and was included mainly to be controlled for in the main analyses. As such, it did not include upward and downward subscales, which may explain why it was not associated with growth mindset endorsement.

Effects of Peers' Growth Mindset on Learning-Related Outcomes

Participants' self-reported change in growth mindset after the growth mindset and social comparison manipulations was of primary interest to this study and a major component of Hypothesis 1. It was expected that the peer growth mindset condition would lead to increased participant growth mindset endorsement, which would increase subsequent motivation and learning-related outcomes. Unexpectedly, no change was observed in participants' post-test growth mindset endorsement, regardless of condition. Numerous factors may have contributed to these contrasting findings, including the superficiality of the manipulated peer environment, the brevity and subtlety of the growth mindset manipulation, and the single time point design. Growth mindset represents a set of implicit beliefs about the nature of a fundamental concept, intelligence, the foundation of which may not be easily shaken, particularly by virtual characters with whom the individual has no prior connection or knowledge of. Had this study been conducted with real adolescent peers whom the participants knew, or perhaps even highly regarded friends, who are more influential than peer groups (Brown et al., 2008), growth mindset change may have been evident. Furthermore, although many single session growth mindset interventions have proven effective at increasing endorsement of growth mindset (e.g., DeBacker et al., 2018), it can sometimes take time for these core beliefs to change (e.g., Blackwell et al., 2007). For this reason, researchers recommend repeated reinforcement of growth mindset messages for optimal effectiveness (Yeager & Dweck, 2020). In this vein, it also may be the case that follow up assessments of growth mindset endorsement after a period of incubation would show evidence of change, which may

subsequently serve as a mechanism of the motivational and behavioral outcomes evident by the manipulation.

Despite no evidence of mindset change, participants in the peer growth mindset conditions showed a clear pattern of improved motivational and learning-related outcomes. Compared with participants in the neutral mindset conditions, the participants identified more with their peers who outperformed them, an adaptive strategy in social comparison scenarios that benefits the learner's motivation while offsetting negative emotional consequences (Buunk et al., 2005). Participants also reported increased perceptions of self-competence, task value and self-regulated learning strategies. Importantly, participants also showed increases in their mastery behaviors, measured via the persistence, effort, resilience, and challenge (PERC) task. This finding is notable because it represents an objective, measurable behavioral outcome. Not only did participants value the task and believe in their abilities to be competent at it, they also showed changes in their observed learning-related behaviors.

These results suggest that adolescents' peers' mindsets do affect their academic outcomes, albeit perhaps not as a direct result of mindset transmission. Rather, it appears that peers' mindsets affect adolescents' learning-related outcomes indirectly, via increased positive perceptions of peers' competence and identification with higher performing peers. This is consistent with Mueller and Dweck's (1998) foundational mindset study, wherein the mindset manipulation affected children's perceptions and behavioral outcomes, including task persistence, challenge-seeking, and enjoyment, rather than mindset per se. As discussed in the introduction, peers are most influential

when they are perceived as possessing desirable qualities and having high status (Cohen & Prinstein, 2006). Believing their growth mindset peers to be competent at the problem-solving task, a desirable quality, adolescents may have felt compelled to modify their behaviors and attitudes so as to conform to their peers, which explains their increased valuing of the task, self-regulated learning strategies, and self-perceptions of competence. Though not assessed in the current study, it is also possible that growth mindset peers may be perceived as more likable and higher in status compared to neutral mindset peers, which would further heighten their influence (Bukowski et al., 2015; Cohen & Prinstein, 2006). Coupled with these increased competence perceptions, adolescents also identified more with their higher performing growth mindset peers, which may have instilled them with optimism and motivation to engage in more learning-related behaviors that were conducive to improvement, so as to conform to their peers. Identification was revealed as the sole mediator in the relationship between peer growth mindset and the observed mastery behaviors. This finding suggests that, beyond adolescents' self-reported changes in attitudes and behaviors, their attempts to aspire to be like their higher performing peers, with whom they identified, were manifested through their mastery behaviors.

Effects of Social Comparison

In contrast to the numerous main effects of the peer growth mindset manipulation, only two main effects of the social comparison manipulation were present. Participants in the upward comparison condition perceived their peers to be higher in competence compared to participants in the neutral comparison condition. This finding was expected, and confirms that the manipulation was effective in persuading participants that their

peers had indeed outperformed them on the problem-solving task. More importantly, there was a main effect of the social comparison manipulation on upward contrast, such that participants in the upward comparison condition contrasted more with their peers who had outperformed them compared to participants in the neutral comparison condition. In other words, the participants were not inspired by their higher performing peers in hopes that their future performance on the task might also be high, but instead felt discouraged that their peers had outperformed them and disconnected themselves from them. Unlike identification (the adaptive social comparison strategy that was shown to be promoted by growth mindset peers), contrast represents a maladaptive social comparison strategy (Buunk et al., 2005). Past literature has shown that students who contrast with their higher performing peers in turn show dampened perceived scholastic competence, and this response also may be related to feelings of imposter syndrome (Boissicat et al., 2012; Chayer & Bouffard, 2010). As such, this finding aligns with past research on the effects of social comparison in the academic context, and the different ways in which students may respond to upward comparison scenarios.

It was expected that the upward social comparison manipulation, in addition to decreasing competence perceptions, may dampen other learning-related outcomes, in contrast to the positive effects of peer growth mindset. The present study did not find evidence of these dampening effects on any other learning-related outcomes, including task effort, value, self-regulated learning, and mastery behaviors. Although these null findings were surprising, they are not entirely inconsistent with past literature, as most of the effects of upward social comparison have revealed negative impacts related to self-

concept and perceptions, rather than overt behaviors (Altermatt & Pomerantz, 2005; Harvey & Keyes, 2019; Trautwein et al., 2009). However, there was also no evidence of social comparison effects on task anxiety, a finding that is at odds with past literature (Butler, 1989; Erdoğan et al., 2011). It may be the case that participants' anxiety was diminished due to the nature of the second problem-solving (PERC) task, which allowed participants to skip questions, examine correct answers and tips, and even included a friendly image of a puppy to boost spirits after the challenging items (Porter et al., 2020). These elements may have reduced participants' concern about their performance on the task so that they did not experience anxiety even when confronted with an upward social comparison scenario. As discussed above, the consequences of upward social comparison also may be diminished through identification with the upward comparison target (Buunk et al., 2005), a variable that was affected by the peer growth mindset manipulation.

The Interplay Between Growth Mindset and Social Comparison

The present study did not find evidence of interactive effects of peer growth mindset and social comparison. This lack of findings was surprising, given prior work linking social comparison and mastery goals (Kamarova et al., 2017) and intervention research demonstrating the positive impact of growth mindset training on social comparison concern (Micari & Pazos, 2014). From a theoretical standpoint, it is presumed that participants' avatar "peers" acted as socialization agents to influence their attitudes and behaviors. This influence operated at the group, as opposed to dyadic, level, wherein attitude and behavioral changes are a function of conformity to group norms and the internalization of group values (Bukowski et al., 2015). The present results suggest

that these processes were effective regarding the influence of peer growth mindset on learning-related outcomes, and were channeled through perceptions of competence and identification with peers. In contrast, the impacts of the social comparison manipulation on learning-related outcomes were substantially weaker. It may be the case that the social comparison scenario was too subtle and/or brief to substantially impact learning-related behavior and interact with the peer growth mindset effects. Perhaps, though it has been utilized in other studies (e.g., Christy & Fox, 2014), the virtual mode of delivery is not optimal for social comparison experiences. Alternatively, these results may speak to the mixed findings regarding upward social comparison effects on learning outcomes, which, though overwhelmingly negative regarding affective outcomes, have been shown to both positively and negatively affect achievement outcomes (Gremmen et al., 2018; Jackson, 2013; Véronneau & Dishion, 2011).

It also must be noted that this study was conducted during the height of the COVID-19 pandemic, a time when the majority of US schools were conducting classes remotely (e.g., via Zoom), and students had limited in-person interaction. Researchers suggest that these changes in students' school environment may have greatly reduced their school engagement (Chiu, 2022). Perhaps these effects were transmitted to the study, and students, already burned out from too many hours on Zoom for school, were not as engaged with the peer avatars and problem solving tasks as they normally would have been. This might also partly explain the lack of difference in participant task anxiety and final Raven's score between the social comparison conditions. Alternatively, the lack

of significant interactions also may have been affected by the study sample size and limited power.

Despite the unexpected lack of interaction effects, the significant main effect of peer growth mindset on identification with peers suggests that peer growth mindset may indeed affect the outcomes of social comparison. Perhaps growth mindset and social comparison processes operate independently, or jointly but not interactively, such that students' learning outcomes are shaped by peer growth mindset and social comparison both separately and as a cascading process. For example, in a classroom where endorsing a growth mindset is the norm, peer growth mindset can help a student cultivate positive perceptions of and identification with their high performing peers, regardless of whether social comparison is present. In turn, increased identification with peers may buffer the adverse consequences of subsequent social comparison experiences, such as when the student does not perform as well as expected on an exam. As such, an alternative model involving mediated pathways, as opposed to moderation, may better represent this process.

Mechanisms of Peer Growth Mindset on Learning-Related Outcomes

Findings indicated that both perceptions of peers' competence and identification with peers in part explained the relationship between peer growth mindset and participant motivational and learning outcomes. The finding that perceptions of peers' competence explained the relationship between peer growth mindset and task value supports prior research that demonstrated this relationship in undergraduate students (Sheffler & Cheung, 2020). Notably, this previous study was conducted in person with live

confederate “peers” instead of remotely using avatars. The present study demonstrates the remarkable versatility of peer growth mindset and its ability to permeate students’ learning motivation through their peers both in real world situations as well as virtual environments. Furthermore, the presence of other outcome variables mediated by perceptions of peers’ competence, including perceptions of self-competence and self-regulated learning, provides evidence that the peer growth mindset effects may be especially influential in adolescents compared to undergraduate students, even when delivered remotely.

Identification with higher performing peers was also a significant mediator in the relationship between peer growth mindset and learning outcomes, a variable which was not examined in the Sheffler & Cheung (2020) study. The present findings suggest that identification with peers may be a stronger mechanism of peer growth mindset effects on learning outcomes, given that the mediation effects of perceptions of peers’ competence were weakened when both mediators were included in model. This finding strengthens the notion of identification as an adaptive strategy when students are faced with an upward comparison scenario (Buunk et al., 2005). The results also contribute to the social comparison literature by shedding light on a new method for fostering this adaptive strategy: growth mindset peers. Encouraging students to talk about the malleability of intelligence with their peers in the classroom may help to cultivate more identification with better performing others, so that students react optimally when faced with peers or friends who outperform them. This tactic could be incorporated in school curriculum, before feedback on assessments is given. The present findings also support the argument

that peer growth mindset affects students' learning outcomes indirectly, rather than through direct mindset to mindset transmission. This aligns with past literature on the effects of other social agents' mindsets on children's growth mindset endorsement, such as parents, who may indirectly affect their children's mindsets through their associated parenting practices (Jose & Bellamy, 2012; Moorman & Pomerantz, 2010). Further investigation of the resulting beliefs students have about their growth mindset peers, as well as potential behaviors students' peers practice, and how these beliefs and behaviors may affect students' mindset endorsement, is warranted.

Limitations and Future Directions

Several limitations must be considered in the interpretation of this study's results. These include the remote and virtual modality of the study, the nature of peer influence, the single session timepoint of the study design, and the materials of assessment. First, as implicated in the study description, the present study was conducted remotely using a virtual peer environment with avatars and recorded statements. Participants did not have the opportunity to interact with live peers, but instead read and listened to their peers' statements passively, without the ability to exchange dialogue or ask questions. As such, results may not be generalizable to real-world peer environments, such as a middle school classroom, in which participants engage in face-to-face dialogue, exchange thoughts and beliefs, and build rapport with their peers. On the other hand, due to changes in learning environments as a result of the COVID-19 pandemic (i.e., increased adoption of online learning, Lockee, 2021), this online paradigm may represent a good proxy for students' interactions in such non-traditional classrooms. For traditional, physical classroom

environments, future research could employ confederate "peers" using child actors, which would better mimic a real-life peer environment and allow mutual dialogue between participants and their peers. Alternatively, naturalistic observation could be utilized to capture genuine peer interactions in the classroom, either in person or remotely (e.g., on Zoom). Trained observers could then code peer statements for growth and fixed mindset themes and code subsequent learning-related behaviors. This design also would allow the study to be expanded beyond a single session timepoint, an additional limitation of this study. Observing adolescents longitudinally in the physical classroom could help shed light on how growth mindset is communicated in adolescents' actual peer environments.

Regarding the nature of peer influence, adolescents ages 12-14 were selected for this study because that is the age at which peer influence is most potent (Berndt, 1979; Brown et al., 2008; De Goede et al., 2009). As discussed, peers represent same-age individuals, who are not necessarily friends, but more acquaintances (Sallee & Tierney, 2007). Although peers have a substantial impact on students' school motivation and achievement (Rodkin & Ryan, 2012; Wentzel & Caldwell, 1997), other research indicates that adolescents' friends may be more influential to their learning outcomes compared to their peer groups (Brown et al., 2008). The design of this study did not permit the investigation of friendship influences, as participants did not know their purported "peers." Future research could modify the design to include friendship dyads or small groups, and perhaps manipulate the types of statements participants hear from their friends to include growth mindset statements. In this way, the peer growth mindset

effects demonstrated in the present study could be compared to friendship effects to assess whether they are indeed stronger.

This study assessed adolescents' learning-related behaviors using several self-report measures and an objective behavioral measure of mastery behaviors using the PERC task. As many of the outcome variables were self-reported, they may not have captured participants' true behaviors due to bias in responses (e.g., social desirability). Furthermore, the Raven's Progressive Matrices problem-solving tasks used in the study as the basis for the learning-related outcomes may not have reflected the types of real-world learning activities adolescents typically pursue. These measures were chosen due to their novelty and application in the PERC task, and because Raven's tests are considered relatively "culture-free" assessments that would not be affected by participants' prior knowledge (Raven, 2000). Had more real-world learning assessments been included, the effects may have been strengthened.

Theoretical and Practical Significance

This study is notable for its conceptual contribution to the growth mindset literature. Although there is ample literature and much intervention research documenting the role of growth mindset in adolescents' academic motivation and achievement, limited research has focused exclusively on growth mindset influence in adolescent peer interactions. Given the substantial role peers play in adolescents' academic lives and identity development (Harter 1990; Yazedjian et al., 2007), further investigation into peer mindset effects helps shed light on how implicit theories of intelligence are socialized in adolescents and the effects their social agent peers have on their learning outcomes. This

knowledge could help inform the design and implementation of future growth mindset interventions aimed at decreasing the academic achievement gap by boosting student motivation and learning outcomes. Furthermore, no studies to date have examined peer growth mindset effects and social comparison concurrently. Although no interaction effects were found, the finding that peer growth mindset may help foster upward comparison identification in adolescents helps increase our understanding of the function of growth mindset in the classroom context, where comparison and evaluation experiences occur frequently. In addition to informing mindset interventions, this knowledge may promote new methods of motivating students struggling with issues of academic self-concept and evaluative anxiety.

Methodological Innovations

This dissertation is also notable for its methodological innovation. The study utilized an entirely novel online experimental paradigm in which artificial peer groups were manipulated using avatars as visual representations. Participants heard and read statements from their "peers" and also received feedback about their and their peers' performance via a virtual leaderboard. In this way, researchers could remotely simulate the types of peer interactions and social comparison experiences students may encounter in the classroom or in other activities with peers. This paradigm represents a unique method of studying peer and social comparison effects without the use of study confederates, imagined scenarios, or other adolescent participants, and can be delivered completely online. Additionally, due to its online format, ease of administration, and cost-effectiveness, this methodology allows access to study participants who may be

traditionally difficult to contact, such as those at great geographic distances or those enrolled in alternatively structured middle school education programs. This could potentially aid this study and future research in gathering participants beyond WEIRD samples (Henrich et al., 2010) in order to increase the representativeness and generalizability of findings related to this research topic.

Conclusion

This dissertation examined the effects of peer growth mindset and social comparison on adolescents' learning-related outcomes. The study utilized a novel, remote design to create a virtual peer environment, which is notable for its innovation and accessibility. Results support past literature demonstrating the impact of social agents' growth mindset beliefs on children's achievement outcomes, making the case that, like parents and teachers, peers deserve a place at the table when designing growth mindset interventions. The present study did not find any interactive effects of peer growth mindset and social comparison on adolescents' learning outcomes, but the overarching effects of peer growth mindset on learning-related outcomes and on adolescents' identification with higher-performing peers underscore peers as a valuable resource in helping to boost students' motivation, given the negative consequences of social comparison on their academic self-perceptions. Incorporating peers into growth mindset interventions may be especially critical during the middle school years when there is a substantial decline in school motivation, and may help improve adolescents' academic experiences so that they feel inspired, rather than threatened, when they "dare to compare."

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Appendices

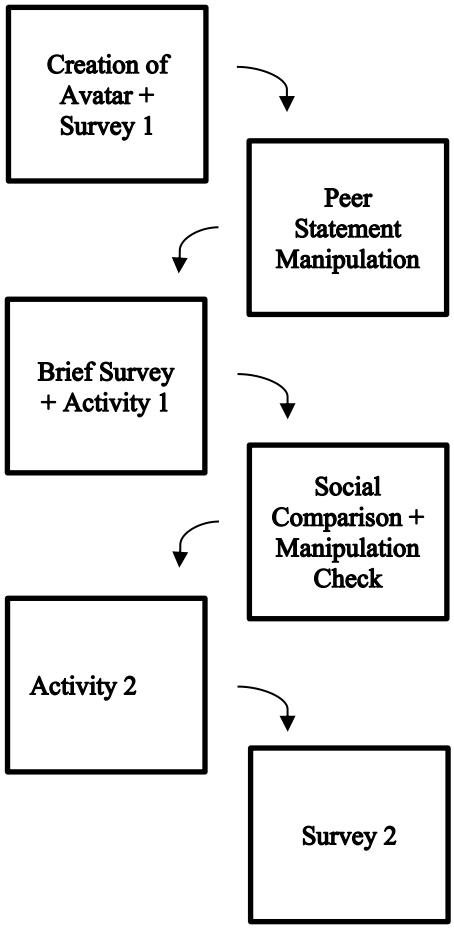
Appendix A

Questionnaires by Survey

Survey 1	Perceptions of academic self-competence
	Achievement goal orientation
	General social comparison
	Implicit theories of intelligence
	General demographics
Brief Survey	Competence perceptions
Manipulation Check	Social comparison comprehension
Survey 2	Social comparison contrast and identification
	Implicit theories of intelligence
	Task specific achievement goal orientation
	Perceptions of competence in the task for self and peers
	Task anxiety
	Task value
	Task effort
	Preference for challenge
	Self-regulated learning

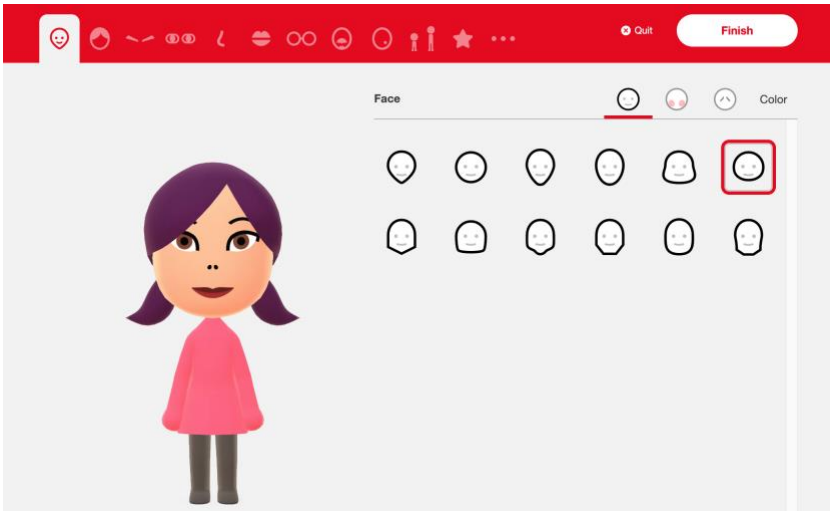
Appendix B

Study Procedure Flowchart



Appendix C

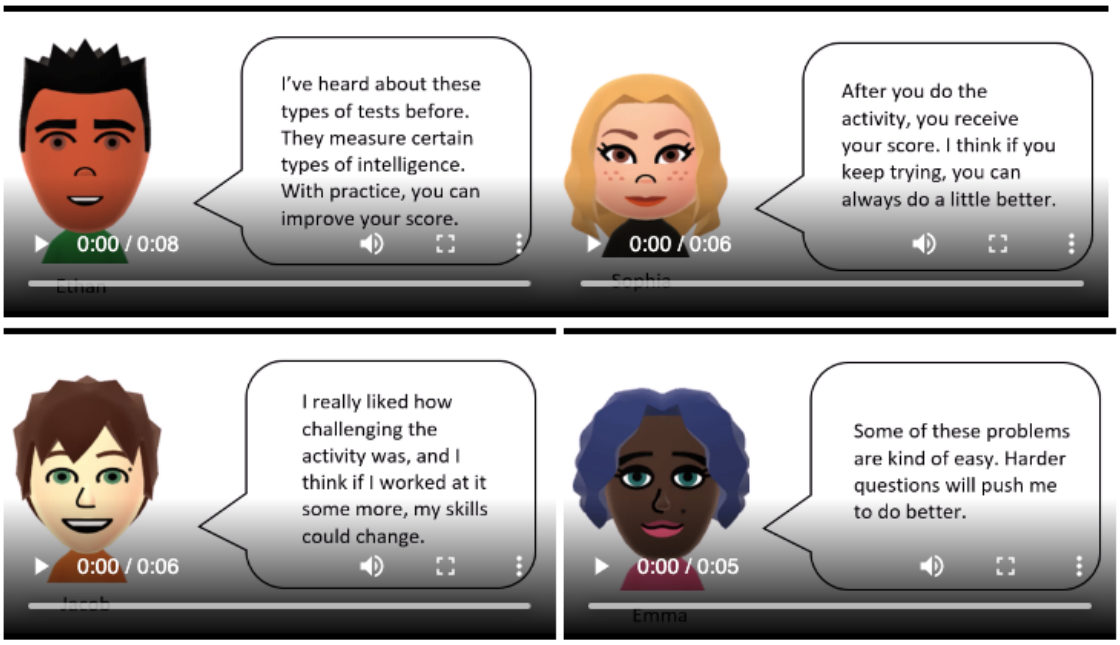
Example Avatar Creation



Note. All avatar images were created using the Nintendo® Mii Studio program and are the copyright material of Nintendo.

Appendix D

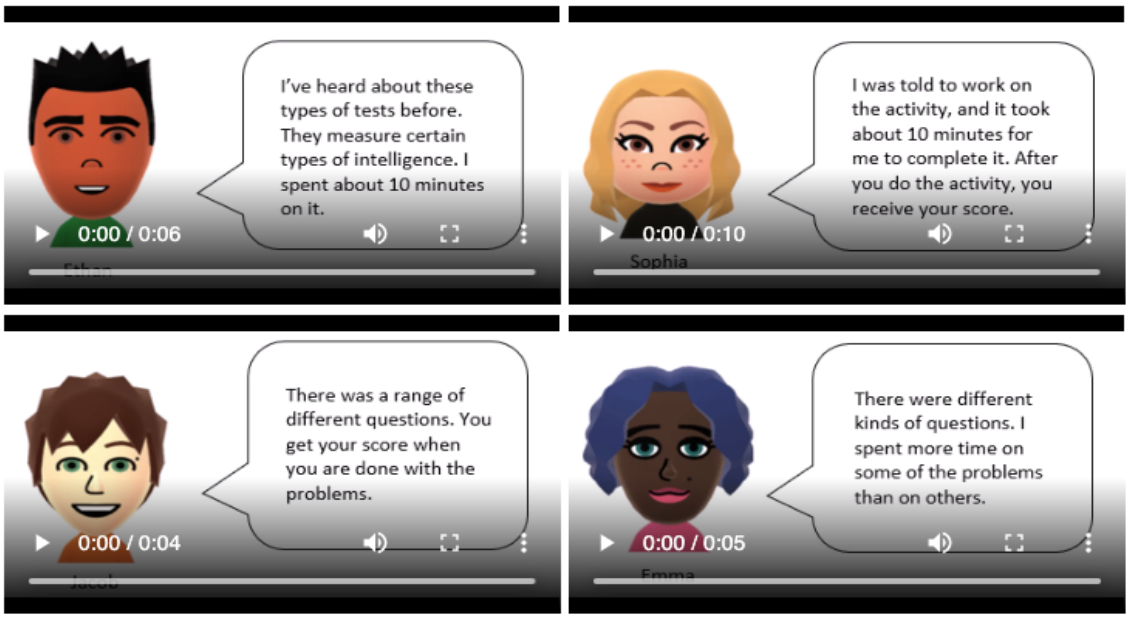
Peer Mindset Manipulation – Growth Mindset Condition



Note. All avatar images were created using the Nintendo® Mii Studio program and are the copyright material of Nintendo.

Appendix E

Peer Mindset Manipulation – Control Condition



Note. All avatar images were created using the Nintendo® Mii Studio program and are the copyright material of Nintendo.

Appendix F

Social Comparison Manipulation

Neutral Comparison Condition

Leaderboard			
Rank	Participant		Score
1		Morgan	98
2		Jose	96
3		Emma	94
4		Jacob	91
5		You	89
6		Ethan	74
7		Sophia	72
8		Mia	70
9		Jayden	69
10		Brooke	65
11		Jorden	61
12		Sam	60
13		Matthew	59
14		Aiden	55
15		Emily	53
16		Jackson	52
17		Finn	49
18		Maya	47
19		Will	45
20		Alex	43

Upward Comparison Condition

Leaderboard			
Rank	Participant		Score
1		Morgan	98
2		Jose	96
3		Emma	94
4		Jacob	91
5		Ethan	89
6		Sophia	74
7		Mia	72
8		Jayden	70
9		Brooke	69
10		Jordan	65
11		Sam	61
12		Matthew	60
13		Aiden	59
14		Emily	55
15		Jackson	53
16		Finn	52
17		Maya	49
18		You	47
19		Will	45
20		Alex	43

Note. All avatar images were created using the Nintendo® Mii Studio program and are the copyright material of Nintendo.

Appendix G

Survey 1

University of California, Riverside
Virtual Learning Project

Survey Packet 1

Instructions: Please **read the brief instructions** for each set of questions carefully; pay attention to the labels above the circles as they often change from one set of questions to the next. Answer the questions as **quickly and accurately** as possible. Sometimes you will see some questions that are similar to ones you have already answered, but this is important to our research. Remember, your answers to the questions are completely **private**. We will not share them with anyone. However, if you would like to share them with someone, that is okay.

Please be sure to answer each question and let the researcher know when you are finished.

There are no right or wrong answers.
We just want to know what you think.

Part 1: My Feelings about School

*For each, shade in the circle showing **how true you think it is**.*

1. How good are you at school?	Not at all good ○	○	Somewhat good ○	○	Very good ○
2. If you were to rank all of the students in your school from the worst to the best, where would you put yourself?	At the bottom ○	○	In the middle ○	○	At the top ○
3. How important is it to you to do *well* in school?	Not at all important ○	○	Somewhat important ○	○	Very important ○
4. How important is it to you to *avoid* doing poorly in school?	Not at all important ○	○	Somewhat important ○	○	Very important ○
5. How much do you *worry* over whether or not you will do well in school?	Not at all ○	○	Somewhat ○	○	Very much ○
6. How important is it to you that you learn a lot in school?	Not at all important ○	○	Somewhat important ○	○	Very important ○
	Not at all		Somewhat		Very much

7. How much do you like to do difficult work in school?	○	○	○	○	○
	None		Some		A lot
8. How much effort do you put into your schoolwork?	○	○	○	○	○

Part 2: My Views About Myself

To what extent do you agree with the following statements? *For each, shade in the circle that corresponds with your response.*

		Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1.	I always pay a lot of attention to how I do things compared with how others do things.	○	○	○	○	○
2.	I often compare how I am doing socially (e.g., social skills, popularity) with other people.	○	○	○	○	○
3.	I am not the type of person who compares often with others.	○	○	○	○	○
4.	I often try to find out what others think who face similar problems as I face.	○	○	○	○	○
5.	I always like to know what others in a similar situation would do.	○	○	○	○	○
6.	If I want to learn more about something, I try to find out what others think about it.	○	○	○	○	○

Part 3: My Views about Intelligence

To what extent do you agree with the following statements?

For each, shade in the circle that corresponds with your response.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1. Your intelligence is something very basic about you that you can't change very much.	○	○	○	○	○
2. No matter how much intelligence you have, you can always change it quite a bit.	○	○	○	○	○
3. You can always substantially change how intelligent you are.	○	○	○	○	○
4. You are a certain kind of person, and there is not much that can be done to really change that.	○	○	○	○	○
5. You can always change basic things about the kind of person you are.	○	○	○	○	○
6. Music talent can be learned by anyone.	○	○	○	○	○
7. Only a few people will be truly good at sports – you have to be "born with it."	○	○	○	○	○
8. Math is much easier to learn if you are male or maybe come from a culture who values math.	○	○	○	○	○
9. The harder you work at something, the better you will be at it.	○	○	○	○	○
10. No matter what kind of person you are, you can always change substantially.	○	○	○	○	○
11. Trying new things is stressful for me and I avoid it.	○	○	○	○	○
12. Some people are good and kind, and some are not – it's not often that people change.	○	○	○	○	○
13. I appreciate when parents, coaches, teachers	○	○	○	○	○

give me feedback about my performance.					
14. I often get angry when I get feedback about my performance.	○	○	○	○	○
15. All human beings without a brain injury or birth defect are capable of the same amount of learning.	○	○	○	○	○
16. You can learn new things, but you can't really change how intelligent you are.	○	○	○	○	○
17. You can do things differently, but the important parts of who you are can't really be changed.	○	○	○	○	○
18. Human beings are basically good, but sometimes make terrible decisions.	○	○	○	○	○
19. An important reason why I do my school work is that I like to learn new things.	○	○	○	○	○
20. Truly smart people do not need to try hard.	○	○	○	○	○

Part 4: Demographics

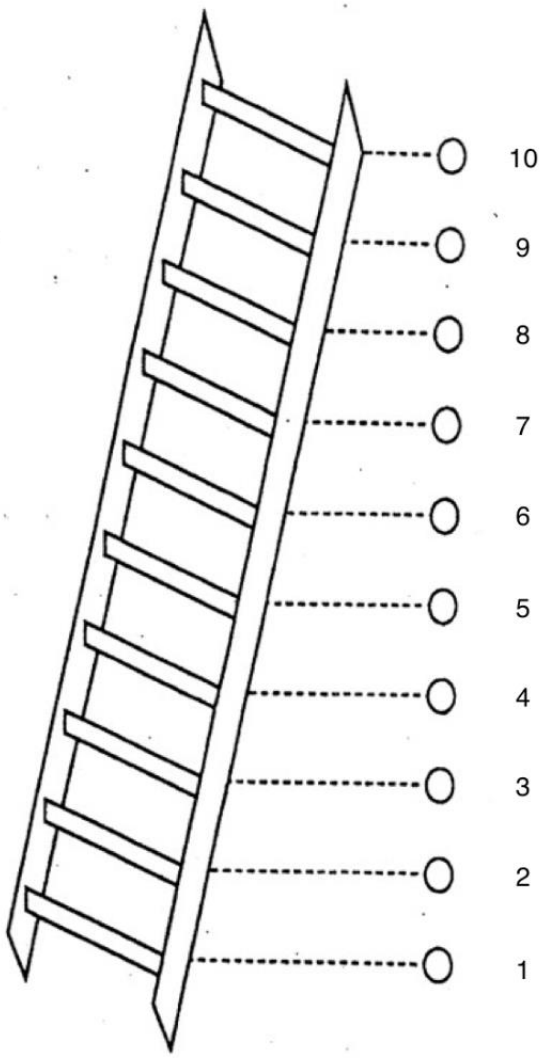
Imagine this ladder pictures how the United States society is set up.

At the top of the ladder are the people who are best off – they have the most money, the highest amount of schooling, and the jobs that bring the most respect.

At the bottom are people who are worst off – they have the least money, little or no education, no job or jobs that no one wants or respects.

Now think about your family. Please tell us where you think your family would be on this ladder.

Shade in the circle that best represents where your family would be on this ladder.



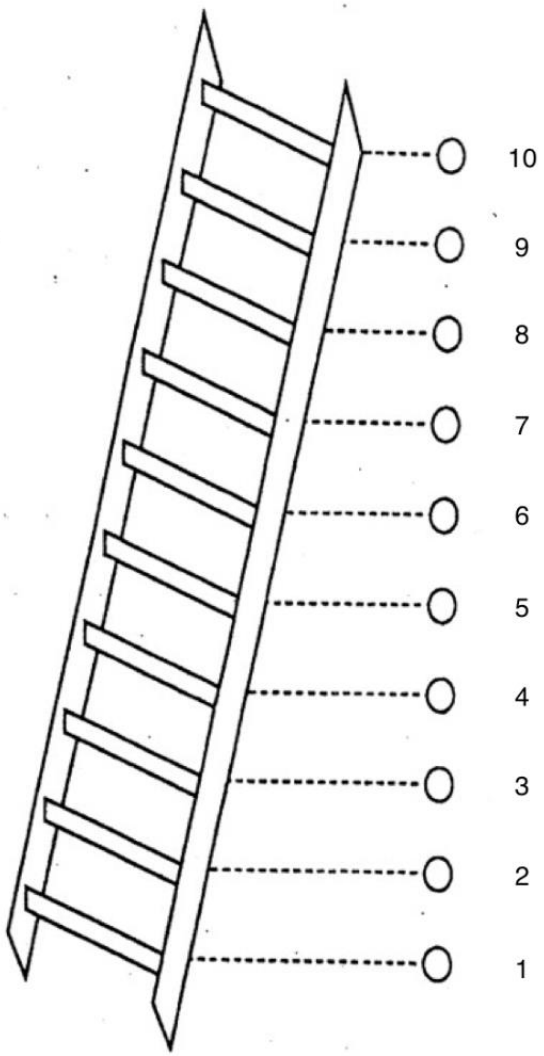
Now assume that the ladder is a way of picturing your school.

At the top of the ladder are the people in your school with the most respect, the highest grades, and the highest standing.

At the bottom are the people who no one respects, no one wants to hang around with, and have the worst grades.

Now think about yourself. Please tell us where you think you would be on this ladder.

Shade in the circle that best represents where you would be on this ladder.



Compared to other students your age, will you be better or worse in the following subjects?

For each, shade in the circle that corresponds with your response.

	A lot worse than others	A little worse than others	The same as others	A little better than others	A lot better than others
1. Math	○	○	○	○	○
2. Science	○	○	○	○	○
3. Writing	○	○	○	○	○
4. Reading	○	○	○	○	○

Additional Information

1. What is your gender?	○ Female ○ Male ○ Other (please specify): _____
3. What is your age?	Age _____
3. What is your year in school?	○ 6th grade ○ 7th grade ○ 8th grade ○ Other (please specify): _____
4. Which of the following best describes your ethnicity/race? (fill in **as many** as apply)	○ American Indian or Alaskan Native ○ Asian or Pacific Islander ○ Black ○ Hispanic/Latinx ○ White ○ Other (please specify): _____

Thank You!

Please let the researcher know when you are finished.

Appendix H

Brief Survey

For each, shade in the circle showing that corresponds with your response.

	A lot worse than others		The same as others		A lot better than others	I don't know
1. Compared to others, will *your peers* be better or worse at the problem-solving activity?	○	○	○	○	○	○
	A lot worse than others		The same as others		A lot better than others	I don't know
2. Compared to others, will *you* be better or worse at the problem-solving activity?	○	○	○	○	○	○
	Not at all well		Somewhat well		Very well	I don't know
3. How well do you think *your peers* performed on the problem-solving activity?	○	○	○	○	○	○
	Not at all well		Somewhat well		Very well	I don't know
4. How well do you think *you* will perform on the problem-solving activity	○	○	○	○	○	○

Appendix I

Manipulation Check

For each, shade in the circle showing that corresponds with your response.

	Not at all well		Somewhat well		Very well
1. How well did *you* perform on the problem-solving activity?	○	○	○	○	○
	Not at all well		Somewhat well		Very well
2. How well did your *peers* perform on the problem-solving activity?	○	○	○	○	○
	Worse than others		The same as others		Better than others
3. Compared to all of the participants, how well did you perform on the problem-solving activity?	○	○	○	○	○
	Worse than my peers		The same as my peers		Better than my peers
4. Compared to your peers, how well did you perform on the problem-solving activity?	○	○	○	○	○

Appendix J

Survey 2

University of California, Riverside
Virtual Learning Project

Survey Packet 2

Instructions: Please **read the brief instructions** for each set of questions carefully; pay attention to the labels above the circles as they often change from one set of questions to the next. Answer the questions as **quickly and accurately** as possible. Sometimes you will see some questions that are similar to ones you have already answered, but this is important to our research. Remember, your answers to the questions are completely **private**. We will not share them with anyone. However, if you would like to share them with someone, that is okay.

Please be sure to answer each question and let the researcher know when you are finished.

There are no right or wrong answers.
We just want to know what you think.

Part 1: My Views About the Task

Think about how you felt after receiving feedback on your and your peers' performance on the problem-solving task. To what extent do you agree with the following statements? *For each, shade in the circle that corresponds with your response.*

		Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1.	I realize that it is possible for my score to also improve.	○	○	○	○	○
2.	I have good hope that my performance on the problem-solving task will improve too.	○	○	○	○	○
3.	I am pleased that my performance can also get better.	○	○	○	○	○
4.	I feel frustrated about my own performance.	○	○	○	○	○
5.	It is threatening to notice that I am doing not so well on the problem-solving task.	○	○	○	○	○
6.	I feel depressed realizing that I am not doing well on the problem-solving task.	○	○	○	○	○
7.	I fear that my performance on the problem-solving task	○	○	○	○	○

	will go along the same way.					
8.	I fear that my future score will be similar.	○	○	○	○	○
9.	I experience fear for my own performance on the task to decline.	○	○	○	○	○
10.	I realize how well I am doing on the problem-solving task.	○	○	○	○	○
11.	I feel relieved about my own performance on the problem-solving task.	○	○	○	○	○
12.	I am happy that I am doing so well myself in the problem-solving task.	○	○	○	○	○

Part 2: My Thoughts about the Task

To what extent do you agree with the following statements? *For each, shade in the circle that corresponds with your response.*

		Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1.	Your skills needed for this problem-solving task can't be changed.	○	○	○	○	○
2.	There is a lot that can be done to change your ability for this task.	○	○	○	○	○
3.	Your ability in this task is something very basic about yourself that can't be changed.	○	○	○	○	○
4.	Through hard work, you can change your ability in this problem-solving task.	○	○	○	○	○

Part 3: My Views about Intelligence

To what extent do you agree with the following statements? *For each, shade in the circle that corresponds with your response.*

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1. Your intelligence is something very basic about you that you can't change very much.	○	○	○	○	○
2. No matter how much intelligence you have, you can always change it quite a bit.	○	○	○	○	○
3. You can always substantially change how intelligent you are.	○	○	○	○	○
4. You are a certain kind of person, and there is not much that can be done to really change that.	○	○	○	○	○
5. You can always change basic things about the kind of person you are.	○	○	○	○	○
6. Music talent can be learned by anyone.	○	○	○	○	○
7. Only a few people will be truly good at sports – you have to be "born with it."	○	○	○	○	○
8. Math is much easier to learn if you are male or maybe come from a culture who values math.	○	○	○	○	○
9. The harder you work at something, the better you will be at it.	○	○	○	○	○
10. No matter what kind of person you are, you can always change substantially.	○	○	○	○	○
11. Trying new things is stressful for me and I avoid it.	○	○	○	○	○
12. Some people are good and kind, and some are not – it's not often that people change.	○	○	○	○	○
13. I appreciate when parents, coaches, teachers	○	○	○	○	○

give me feedback about my performance.					
14. I often get angry when I get feedback about my performance.	○	○	○	○	○
15. All human beings without a brain injury or birth defect are capable of the same amount of learning.	○	○	○	○	○
16. You can learn new things, but you can't really change how intelligent you are.	○	○	○	○	○
17. You can do things differently, but the important parts of who you are can't really be changed.	○	○	○	○	○
18. Human beings are basically good, but sometimes make terrible decisions.	○	○	○	○	○
19. An important reason why I do my school work is that I like to learn new things.	○	○	○	○	○
20. Truly smart people do not need to try hard.	○	○	○	○	○

Part 4: My Goals in the Task

*For each, shade in the circle showing **how true you think it is**.*

		Not at all important		Somewhat important		Very important
5.	How important is it to you to do *well* on the problem-solving task?	○	○	○	○	○
		Not at all important		Somewhat important		Very important
6.	How important is it to you to *avoid* doing poorly on the problem-solving task?	○	○	○	○	○
		Not at all		Somewhat		Very much
7.	How much do you *worry* over whether or not you will do well in the problem-solving task?	○	○	○	○	○
		Not at all important		Somewhat important		Very important
8.	How important is it to you that you learn a lot from the problem-solving task?	○	○	○	○	○
		Not at all		Somewhat		Very much
9.	How much did you enjoy the difficult parts of the problem-solving task?	○	○	○	○	○
		None		Some		A lot
10.	How much persistence did you put in the problem-solving task?	○	○	○	○	○

Part 5: My Beliefs about the Task

*Please respond to each of the following items in terms of how true it is for you with respect to **YOUR** performance in this study.*

	Not at all true		Somewhat true		Very True
1. I feel confident in my ability to improve at the task	○	○	○	○	○
2. I am capable of learning the material in the task	○	○	○	○	○
3. I am able to achieve my goals in this task	○	○	○	○	○
4. I feel able to meet the challenges of performing well in this task	○	○	○	○	○

*Please respond to each of the following items in terms of how true it is for you with respect to the **OTHER PARTICIPANTS'** performance in this study.*

	Not at all true		Somewhat true		Very True
1. They feel confident in their ability to improve at the task	○	○	○	○	○
2. They are capable of learning the material in the task	○	○	○	○	○
3. They are able to achieve their goals in this task	○	○	○	○	○
4. They feel that they are able to meet the challenges of performing well in this task	○	○	○	○	○

Part 6: My Feelings About the Task

To what extent do you agree with the following statements? *For each, shade in the circle that corresponds with your response.*

		Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1.	During the problem-solving task I felt very tense.	○	○	○	○	○
2.	I wish activities like these did not bother me so much.	○	○	○	○	○
3.	I seemed to defeat myself while working on the problem-solving task.	○	○	○	○	○
4.	I felt very panicky when I was working on the problem-solving task.	○	○	○	○	○
5.	During the problem-solving activity I got so nervous that I forgot facts I really know.	○	○	○	○	○

Part 7: My Performance on the Task

Please respond to each of the following items in terms of how true it is for you with respect to the problem-solving task.

	Not at All True	A Little Bit Important	Kind of True	Pretty Important	Very True
1. It's important to me to do well on these problems.	○	○	○	○	○
2. How I do on these problems doesn't really matter to me.	○	○	○	○	○
3. It's important to me to get the answers right answers on the problems.	○	○	○	○	○
4. I don't care that much if I get the answers wrong.	○	○	○	○	○
5. After choosing my answers on the problems, I checked again to be sure they were correct.	○	○	○	○	○
6. When I was working on the problems, I paid close attention to what was changing in the patterns.	○	○	○	○	○
7. When the patterns were confusing, I tried different ways at looking at them.	○	○	○	○	○
8. I tried to eliminate answers that were clearly **NOT** correct.	○	○	○	○	○
9. I made sure I understood what was changing in the patterns.	○	○	○	○	○
10. I double-checked my work.	○	○	○	○	○
11. I am pretty smart when it comes to the kind of problems I just worked on.	○	○	○	○	○
12. I am as good as other people my age on these problems.	○	○	○	○	○
13. I am worse than other people my age at solving these problems.	○	○	○	○	○
14. I am not good at finding the right answers on problems like those I completed.	○	○	○	○	○
15. If I work on another set of problems like these, I will probably get a lot wrong.	○	○	○	○	○
16. I will probably do pretty well on another set of problems like these.	○	○	○	○	○

Part 8: My Learning Style

For each statement below, please shade in the circle that shows how true it is of you.

		Not at All True	A Little Bit True	Kind of True	Pretty True	Very True
1.	I checked to see if I understood the things I was trying to learn during the activity.	○	○	○	○	○
2.	I looked through the activity to see how things were arranged before I started.	○	○	○	○	○
3.	I tried to decide what parts of the activity I didn't understand.	○	○	○	○	○
4.	I tried to plan out the activity as best as I could.	○	○	○	○	○
5.	When I was working on the activity, I checked to see if I understood it.	○	○	○	○	○
6.	I planned ahead so that I could do well on the activity.	○	○	○	○	○
7.	I tried to understand how the things I was learning in the activity were related to other things I know.	○	○	○	○	○
8.	When doing the activity I picked out the most important parts first.	○	○	○	○	○
9.	I tried to decide what parts of the activity I didn't know as well as others.	○	○	○	○	○
10.	I tried to match what I already know with the things I was learning in the activity.	○	○	○	○	○
11.	I tried to see the similarities and differences in the things I was learning in the activity with things I already know.	○	○	○	○	○
12.	When working on the activity, I tried to see how things fit together with things I already know.	○	○	○	○	○

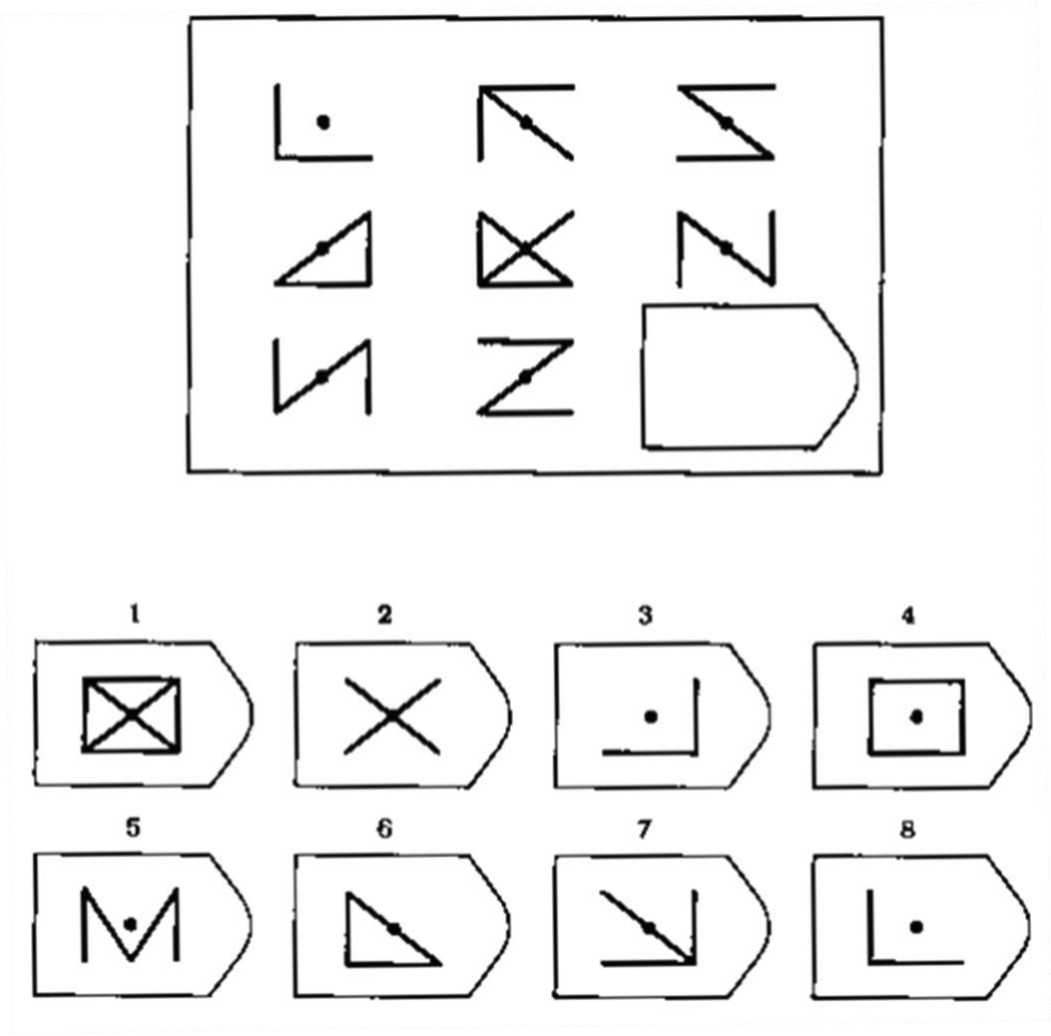
Thank You!

Please let the researcher know when you are finished.

Appendix K

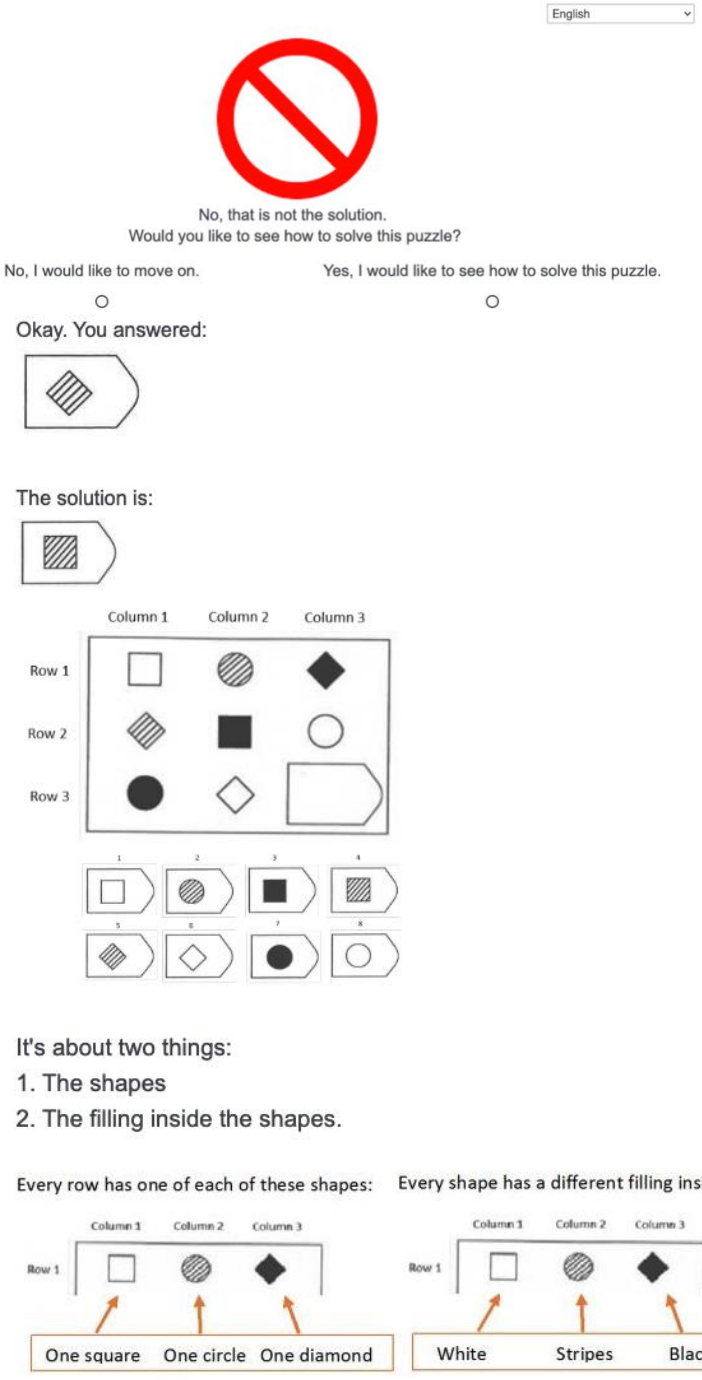
Sample Raven's Progressive Matrices Item

Please select the answer that best completes the pattern.



Appendix L

Sample PERC Item



Note. Sample item from the PERC task (Porter, 2020).

Appendix M

Model Fit Indices Comparing Constrained Versus Unconstrained Paths

Model	χ^2	*p*	*df*	CFI	TLI	RMSEA	$\Delta\chi^2$
Constrained Path							
Perceptions of PC							
Unconstrained	0.00	.000	0	1.00	1.00	.00	-
Peer GM → SRL	0.24	.627	1	1.00	1.00	.00	0.24
Perceptions of PC → SRL	5.01	.025	1	0.97	0.00	.27	5.01*
Peer GM → Task Value	1.43	.232	1	1.00	0.71	.09	1.43
Perceptions of PC → Task Value	1.82	.177	1	0.99	0.45	.12	1.82
Peer GM → Self-Competence	0.01	.911	1	1.00	1.00	.00	0.01
Perceptions of PC → Self-Competence	0.09	.760	1	1.00	1.00	.00	0.09
Peer GM → Mastery Behaviors	1.16	.280	1	1.00	0.89	.05	1.16
Perceptions of PC → Mastery Behaviors	0.45	.501	1	1.000	1.00	.00	0.45
Peer GM → Perceptions of PC	0.36	.551	1	1.000	1.00	.00	0.36
Final Model	5.64	.688	8	1.000	1.00	.00	5.64
Identification							
Unconstrained	0.00	.000	0	1.00	1.00	.00	-
Peer GM → SRL	0.02	.881	1	1.00	1.00	.00	0.02
Identification → SRL	0.35	.554	1	1.00	1.00	.00	0.35

Peer GM → Task Value	0.40	.524	1	1.00	1.00	.00	0.40
Identification → Task Value	0.75	.386	1	1.00	1.00	.00	0.75
Peer GM → Self-Competence	0.10	.746	1	1.00	1.00	.00	0.10
Identification → Self-Competence	0.66	.422	1	1.00	1.00	.00	0.66
Peer GM → Mastery Behaviors	0.98	.322	1	1.00	1.00	.00	0.98
Identification → Mastery Behaviors	0.17	.681	1	1.00	1.00	.00	0.17
Peer GM → Identification	0.10	.756	1	1.00	1.00	.00	0.10
Final Model	5.48	.791	9	1.00	1.00	.00	5.48
Combined Model							
Unconstrained	6.42	.040	2	0.98	0.00	.20	-
Peer GM → SRL	6.44	.092	3	0.98	0.30	.14	0.02
Perceptions of PC → SRL	13.34	.052	3	0.98	0.04	.17	6.92*
Identification → SRL	7.69	.004	3	0.94	0.00	.25	1.27
Peer GM → Task Value	7.04	.070	3	0.98	0.18	.15	0.62
Perceptions of PC → Task Value	9.22	.050	3	0.97	0.03	.17	2.80
Identification → Task Value	7.78	.026	3	0.97	0.00	.19	1.36
Peer GM → Self-Competence	6.45	.091	3	0.98	0.30	.14	0.03
Perceptions of PC → Self-Competence	6.54	.058	3	0.98	0.09	.16	0.12
Identification → Self-Competence	7.45	.088	3	0.98	0.28	.15	1.03
Peer GM → Mastery Behaviors	7.32	.062	3	0.98	0.12	.16	0.90
Perceptions of PC → Mastery Behaviors	6.65	.088	3	0.98	0.28	.14	0.23
Identification → Mastery Behaviors	6.53	.083	3	0.98	0.26	.15	0.11

Peer GM → Perceptions of PC	6.78	.088	3	0.98	0.28	.14	0.36
Peer GM → Identification	6.52	.079	3	0.98	0.23	.15	0.10
Final Model	16.47	.351	15	0.99	0.94	.04	10.05

Note. GM refers to growth mindset, PC refers to peers' competence, SRL refers to self-regulated learning. *Chi-square difference significant at $p < .05$. Each path indicates a comparison with the fully unconstrained model.