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RESEARCH PAPER

Changing Minds: An RCT of a Growth Mindset Intervention on Depressive Symptoms and Well-being in Adolescent Girls and Boys

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Abstract

Single session growth mindset interventions can limit the development of depressive symptoms among high school students, yet, few studies have examined whether these interventions affect well-being or differ depending on gender. This study examined the effects of a growth mindset of personality intervention on primary outcomes of depressive symptoms and well-being (i.e., subjective happiness and life satisfaction) in adolescent girls and boys. In a parallel, 2(time) x 2(condition) x 2(gender), randomized control trial using 1:1 blinded allocation, participants were assigned to an experimental (growth mindset of personality) or control intervention (growth mindset of athletic ability). English speaking students in grade 9 and 12 (ages 13–18 years) at three high schools in Ontario, Canada were recruited, and reported depressive symptoms and well-being at baseline and 4-months follow-up.

Of 472 participants, 318 participants (58% girls, 60.8% white, M age = 14.9 years) returned for follow-up and were analyzed (experimental, $n = 167$; control, $n = 152$). A three-way interaction was identified ($F(1,308) = 6.81$, $p = .01$, $\eta^2 = 0.022$) such that girls endorsed reduced depressive symptoms at follow-up in the experimental condition ($d = 0.31$), but no such change was observed in boys ($d = 0.07$). The experimental intervention had no effect on subjective happiness, and effects on life satisfaction require further investigation.

Single session growth mindset interventions may be helpful for depressive symptoms in adolescent girls. Future research should examine longer follow-ups and explore intervention features most applicable to boys. Clinical trial registration #: NCT04133389.

Keywords Mindset · Intervention · Depression · Well-being

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1 Introduction

Adolescence is a period of transition with heightened risk for depressive symptomatology and disorders (Hankin, 2009; Merikangas et al., 2010). Youth mental illness has become a major focus for youth health globally (World Health Organization, 2003). Depression often develops during adolescence, and is associated with increased risk for suicide, and substantial psychosocial impairments (Balázs et al., 2013). Rates of clinical depression rise substantially during adolescence with recent data indicating a prevalence rate of 8% at age 13–14, increasing to a prevalence of 15% by age 18 (Merikangas et al., 2010). In response to this increased risk, depressive symptoms have become an important target of preventative efforts, and many researchers recommend programs that can be disseminated to adolescents via educational systems (Masten et al., 2018; Seligman et al., 2009). Single session online interventions, which are brief and are not reliant on specially trained or clinical administrators, are amenable to wide dissemination (Schleider & Weisz, 2018). Meta-analytic findings indicate an overall positive impact of single session interventions on a range of psychological problems; however, effects on depressive symptoms were non-significant overall, and are thus in need of more study (Schleider & Wiesz, 2017).

Given that central beliefs about the self, future, and world are theorized to underlie the development of depression (Beck, 1967), growth mindset beliefs about personality have been identified as a potential target for interventions aiming to reduce or prevent depressive symptoms (Yeager & Dweck, 2012). Growth mindset refers to possessing the belief that personal characteristics can grow and change (Dweck & Legget, 1988). Initial intervention studies targeting growth mindset have shown protective effects against or reductions in depressive symptoms (Miu & Yeager, 2015), however not all interventions evidence positive effects (Calvete et al., 2019). Interventions studied to date vary in length (single session vs. multiple session), method of presentation (online vs. paper), types of activities (reading vs. interactive/ videos), length of follow-up, and population focus (e.g., community sample, at risk groups, girls only; Calvete et al., 2019; Miu & Yeager, 2015; Schleider & Weisz, 2018; Schleider et al., 2020). Further, the impacts of growth mindset of personality interventions have largely focused on outcomes of psychopathology or dysfunction, and in line with a positive clinical psychology approach (e.g., Wood & Tarrier, 2010), there is a need to also consider the potential positive impacts of these interventions on youth well-being. Finally, despite important gender differences in depressive symptomology (e.g., higher risk of disorder and earlier onset of symptoms amongst girls; Crockett et al., 2020, Hankin, 2009), previous research has rarely considered how effects of growth mindset of personality interventions may differ between genders. Thus, the current study aims to examine the impacts of growth mindset intervention targeting depressive symptoms using online content in a single session, examining both outcomes of psychopathology and wellbeing, and directly assessing the role of gender in intervention effectiveness.

1.1 Growth Mindset

Although mindset was initially examined in the academic domain (e.g., targeting beliefs about academic ability), individuals also hold mindset beliefs about the malleability of personal characteristics that define themselves and others (e.g., one's likability, social roles); such beliefs are referred to as mindset of *personality* (Dweck et al., 1995; Erdley et al., 1997; Yeager & Dweck, 2012). Holding a growth mindset of personality is associated with lower levels of psychological distress, including depressive symptoms as observed in meta-anaytic investigation (Burnette et al., 2020; Schleider et al., 2015). Prominent theories of the development of depression have long identified the role of cognition, and postulated that beliefs about the stability of self, others, and the world reflect a specific vulnerability (Abramson et al., 1989; Beck, 1967; Hankin, 2009). The theory of mindset of personality aligns with these social cognitive theories of depression. Mindset shares particular similarities to Abramson's (1989) theory, in which individuals are theorized to hold attributional styles with themes related to success in interpersonal domains (e.g., that lack of success with friendships may be stable). Indeed, mindsets have been described as core beliefs (Blackwell et al., 2007), that influence one's interpretation and understanding of the world and one's experiences (Miu & Yeager, 2015). Researchers argue that mindset regarding the malleability of personal characteristics becomes a framework for predictions and interpretations of events (Yeager & Dweck, 2012), and influences responses to adversity and challenge (Miu & Yeager, 2015). In particular, beliefs about malleability of personality can influence an individual's processing of social information, such that attributions and judgments vary with mindset (growth vs. fixed) (Dweck et al., 1995). Those who endorse a fixed mindset of personality tend to attribute behavior and outcomes to an individual's traits, and assume that current behavior is predictive of future behavior. Whereas those who hold a growth mindset of personality tend to focus more on external or situational mediators when making causal attributions of behavior and are less likely to assume that current behavior is predictive of future behavior (Dweck et al. ,1995).

Adolescents who hold a fixed mindset of personality are more likely to respond helplessly when they encounter social challenges, such as peer victimization (Yeager et al., 2013). Erdley and colleagues (1997) found that children's mindset of personality predicted response to social failures, such that those with a fixed mindset were more likely to withdraw effort in social interactions, believe they were not a likable person, express fewer positive emotions. Having a fixed mindset is associated with a host of negative outcomes for children and adolescents such as lower use of cognitive reappraisal, poor social functioning, and higher depressive symptoms (Tamir et al., 2007; Yeager et al., 2013a). Positive relationships with peers are positively associated with overall wellbeing, and support the development of resilience (Masten et al., 2008). Peer victimization, and low perceived social support may put adolescents at risk for poor mental health (Rigby, 2000).

Given the cascade of social and cognitive processes that are tied to mindset beliefs, teaching a growth mindset of personality is promising for the reduction of negative attributions associated with social challenges, and for fostering prosocial behaviour that can reduce risk for depression. In adolescence in particular, social relations are of

central importance and can substantially impact mental health and well-being while also being a potential source of adversity that can increase risk for depression (Nolan et al., 2003). Further, because mindset beliefs are theorized to form during challenging transitions often present during this developmental phase (Dweck, 2006), adolescence is an ideal intervention window.

1.2 Growth Mindset Interventions

Mindset beliefs appear responsive to intervention, such that teaching growth mindset can lead to greater endorsement of growth mindset beliefs (Blackwell et al., 2007; Schleider et al., 2020). More importantly, teaching a growth mindset appears to improve a number of meaningful outcomes, such as depressive symptoms and negative attributions (Miu & Yeager, 2015; Yeager et al., 2013). Lab studies have found that teaching a growth mindset of personality led to faster recovery from social stressors in teens aged 12–15 (Schleider & Weisz, 2016b), and a lower likelihood of attributions of hostile intent after 8 months (Yeager et al., 2013).

In one key intervention study, students entering high school read a compelling article that taught growth mindset of either personality (experimental) or athletic ability (control), then were asked to summarize the lesson of the article and apply it to their own experience using an activity intended to increase internalization of the intervention's message. This single session intervention was associated with the stability of reported levels of depressive symptoms over 9 months while those in the control condition showed an increase in depressive symptoms (Miu & Yeager, 2015). The increase seen in the control condition was noted to be proportional to that commonly experienced by those transitioning to high school (Merikangas et al., 2010; Miu & Yeager, 2015), suggesting such interventions have promise for buffering against developmentally typical increases in depressive symptoms during adolescence.

Length and design of intervention, control group, follow-up period, and sample composition often vary among intervention studies, but taken together, findings point to a meaningful impact on depressive symptoms. For example, an engaging single session online growth mindset intervention reduced depressive symptoms endorsed by high risk youth aged 12–15 at 9-months follow-up (Schleider & Weisz, 2018). Another similar single session online growth mindset intervention led to a reduction in depressive symptoms in rural grade 10 girls compared to a sexual health control over 4-months follow-up (Schleider et al., 2020). Notably, across domains of growth mindset (academic and personality), it is argued that these brief growth mindset interventions are scalable and could effectively be disseminated to a wide range of students (Paunesku et al., 2015; Schlieder & Weisz, 2018; Yeager et al., 2016). Despite these promising findings, Calvete and collegues (2019) found mixed effects in a double blind, randomized controlled trial of a paper and pencil growth mindset of personality intervention versus an educational control in a sample of 867 grade 8–10 students in Spain after 12-months follow-up. Depressive symptoms were reduced in grade 8 students, remained stable in grade 10 students, and surprisingly, increased in those in grade 9 (Calvete et al., 2019). It may be that a paper and pencil style of intervention is less engaging and impactful than more interactive formats. All these

design factors, as well as participant engagement, should be considered in design of further intervention studies.

In a recent meta-analysis assessing growth mindset interventions spanning both academic and mental health domains, findings indicated that the growth mindset intervention literature is characterized by heterogeneity (Burnette et al., 2022). Due to the varability of outcomes, intervention practices, hypothesized mediators, and moderators (target groups), analyses were organized by domain and evaluated the impact of moderators and intervention fidelity on intervention effectiveness. Within the domain of mental health outcomes, most interventions were found to be a single session and approximately half an hour in length. Despite substantial heterogeneity, when implemented with high fidelity and targeting groups most likely to benefit from the intervention, meta-analytic findings suggest a potential average impact of $d = 0.32$ for interventions targeting mental health outcomes. However, because implementation practices vary widely and moderators strongly impact effectiveness, further research that uses high intervention fidelity and examines the effect on moderators are needed to identify best practices.

1.3 Outcomes of Well-being

Much extant growth mindset intervention literature examines impacts on adolescent psychopathology, however, such exclusive focus on reduction of negative experience has been criticized in psychological science (Wood & Tarrier, 2010). A stronger approach jointly considers how multiple related outcomes may function together (e.g., depressive symptoms and life satisfaction; Gruman et al., 2018). Well-being, which consists of both affective experiences of happiness and cognitive appraisals of life satisfaction (Diener et al., 2003), is predictive of a number of important outcomes including improved social relationships (see Diener et al., 2017). Unfortunately, well-being tends to decrease thoughout adolescence (González-Carrasco et al., 2017). Thus, the current study aimed to examine growth mindset intervention impacts on a wider set of youth outcomes, including depressive symptoms and well-being (both subjective happiness and life satisfaction). Well-being is also strongly associated with and influenced by social relationships (Tay & Diener, 2011). Thus, although there is some evidence linking growth mindset and well-being, these relations are yet to be examined within the context of a growth mindset of *personality* intervention. Such research would broaden understanding about the potential impacts of interventions beyond the potential decrease of psychopathology (e.g., depressive symptoms).

1.4 The Role of Gender

In addition to several other known risk factors in adolescence, gender, specifically being women and girls, has been well established as conferring higher risk for development of depressive symptoms, a difference that emerges as early as age 13 (Crockett et al., 2020; Hankin, 2009). Similarly, reductions in well-being throughout adolescence are more pronounced in girls (González-Carrasco et al., 2017). As such, some growth mindset intervention research has focused exclusively on girls

(Schleider et al., 2020). Despite the differing experience and development of mental health challenges between boys and girls in adolescence, meta-analyses of growth mindset interventions found that most studies do not investigate gender-based differences (Schleider et al., 2015). In their most recent meta-analysis, Burnette and colleagues (2022) emphasize the importance of the assessment of moderators in growth mindset interventions, and in understanding the effects on focal (targeted) groups. However, gender has not been explored as a key moderator (Burnette et al., 2020). Thus, it is important to better understand how differing experience of depressive symptoms and well-being between genders may impact intervention effectiveness.

1.5 Present Study

The current study examined whether a 30-minute single session growth mindset of personality intervention would impact primary outcomes of high school student depressive symptoms, subjective happiness, and life satisfaction over 4-months follow-up. Although there is evidence of association between growth mindset and risk for depression (Burnette et al., 2020), and promise of growth mindset of personality interventions (Miu & Yeager, 2015; Schleider et al., 2020; Schlieder & Weisz, 2018), there is a wide variety of designs, format for delivery, follow-up periods, outcome measures, and populations targeted among such interventions. Further to this variability, not all interventions have seen similar effects (e.g., Calvete et al., 2019); this body of work is still developing, and more comparison across studies is needed to clarify the most effective design, method for delivery, and target group to build a cumulative knowledge that can then be applied more widely. More specifically, there has been little focus on considering broader potential impacts on youth outcomes that include well-being, little understanding of effects between genders, and in non-selected secondary school community sample. Therefore, using a novel online intervention, the current study sought to replicate and build on the current literature in the following ways: (1) to explore/replicate effects of previous mindset of personality interventions on depressive symptoms (Miu & Yeager, 2015; Paunesku et al., 2015; Schleider et al., 2020; Schleider & Weisz, 2018; Yeager et al., 2016); (2) compare treatment effects with those for an active treatment control group; (3) to broaden outcome varibles of interest to include of well-being (i.e., happiness and life satisfaction); and (4) and considered the role of gender in intervention effects. We also examined whether the intervention would impact secondary outcomes of growth mindset of personality (using a specific growth mindset of personality measure, and a general growth mindset measure). Specifically, the current study was guided by the following research questions and hypotheses:

RQ1: Immediately following intervention, will the change in endorsement of growth mindset within-subjects from baseline to post-test differ between experimental and control conditions? H1: We hypothesized an interaction between the effects of condition and time on growth mindset immediately post-intervention such that endorsement of growth mindset would increase across time points in the experimental condition but remain the same in the control condition.

RQ2: Following intervention, will the change in endorsement of growth mindset within-subjects from baseline to 4 month follow-up differ between experimental and

control condition? H2: We hypothesized an interaction between the effects of condition and time on growth mindset such that endorsement of growth mindset would increase across time points in the experimental condition but remain the same in the control condition.

RQ3: Following intervention, will the change in depressive symptoms within-subjects from baseline to 4 month follow-up differ between experimental and control conditions? H3: We hypothesized an interaction between the effects of condition and time on depressive symptoms. Specifically, it was expected that those in the experimental condition would show no change, and those in the control condition would endorse more in reported depressive symptoms (reflecting normative development of depressive symptoms over time). Given the relationship between gender and depressive symptoms, gender differences were explored in this model.

RQ4: Following intervention, will the change in well-being (as measured by life satisfaction and subjective happiness) within-subjects from baseline to 4 month follow-up differ between the experimental and control conditions? H4: We hypothesized an interaction between the effects of condition and time on wellbeing (i.e., life satisfaction and happiness) such that those in the experimental condition would endorse an increase in wellbeing over time, and those in the control condition would show no significant change. Given the relationship between gender and well-being, gender differences were explored in this model.

2 Method

2.1 Design

The study design and outcomes were pre-registered with clinicaltrials.gov (Identifier # NCT04133389); the full protocol is available in the supplementary materials. The study was a parallel randomized controlled trial that employed a 2 (condition – between participants) by 2 (time – within participants) by 2 (gender – between participants) mixed measures design to assess a brief online growth mindset of personality intervention. Participants were randomly assigned to one of two conditions (experimental or control) in a 1:1 allocation ratio, and data were collected from each participant at two time points. Primary outcomes were depressive symptoms, life satisfaction, and subjective happiness scores at 4 months follow-up. Secondary outcomes were growth mindset measures immediately post-intervention, and at 4 months follow-up.

2.2 Participants

Participants were recruited from three public high schools within a medium sized city in southwestern Ontario, Canada. Students from grade 9 and 12 classes (those transitioning in and out of high school) who could read and write in English were eligible and invited to participate. Students in grades 10 and 11 who were enrolled in grade 9 and 12 classes were not excluded. Parental consent forms were distributed via classroom teachers to all eligible students, and partcipants were enrolled when

consent forms were returned. Student assent was obtained prior to initiation of study procedures.

Power analyses indicated a minimum sample size of 176 would be needed to detect a an interaction effect with a power of 0.80, effect size of $d = 0.15$ (as per Miu & Yeager, 2015), and an estimated correlation between repeated measures of 0.3, across the time points using a mixed measure 2×2×2 ANOVA (calculated using G*Power).

2.3 Procedure

2.3.1 Data Collection

With obtained parental consent, students attended a data collection at their school to complete the study online. Participants were offered an incentive (i.e., 1 in 50 chance to win a $25 gift card). Participant assent was obtained via the online survey system prior to administration.

Depressive symptoms, subjective happiness, and life satisfaction data were collected at two time points: baseline and 4 months post intervention (primary outcomes). Replicating research in this field (Aronson et al., 2002; Burnette et al., 2018; Schleider et al., 2020), and in keeping with recommendations from a recent review (Burnette et al., 2022) to measure the effect of interventions on growth mindset, growth mindset of personality and general growth mindset beliefs were assessed at three time points: baseline, immediately post-intervention, and at 4 months follow-up (secondary outcomes). Multiple measurements allowed for the assessment of both the immediate and longer-term impacts of the intervention on growth mindset beliefs. Measurement of growth mindset immediately post-intervention occurred in the same session as baseline data collection and the intervention. The study took place in the library, classroom, or computer lab of participants' high schools.

2.3.2 Randomization and Blinding

Participants were randomly assigned to learn growth mindset of either personality (experimental condition) or athletic ability (control), similar to previous research (Miu & Yeager, 2015). Participants were randomly assigned within the Qualtrics survey using the Qualtrics randomizer and "evenly present elements" functions[1]. Thus, researchers and participants were blinded to allocation during intervention administration as well as during pre- and post-intervention data collection.

2.3.3 Interventions

Following collection of baseline data, participants viewed one of two 30-minute growth mindset interventions administered using the same online system (Qualtrics) used for data collection. The experimental condition taught growth mindset of

[1] Qualtrics' randomizer uses a Mersenne Twister algorithm to randomly assign condition. The "evenly present elements" function tracks allocation to ensure even participant assignment per condition using a block size of 2.

personality while the control condition taught growth mindset of athletic ability[2]. A novel educational program targeting youth growth mindset was developed for this research.

Participants were taught a growth mindset in a manner similar to previous brief growth mindset interventions designed by Miu and Yeager (2015) and Burnette et al. (2018). Each intervention condition included 5 sections: (1) introduction to growth mindset, (2) details about growth mindset of either personality or athletic ability, scientific information about neuroplasticity, and tips for applying growth mindset, (3) tips and examples from students and celebrities, (4) a review of concepts and a "saying-is-believing" task replicated from Miu and Yeager (2015) and in keeping with recommendations from a recent review (Burnette et al., 2022) in which participants were instructed to write their own example of growth mindset, and (5) a four-part goal setting task as replicated from extant growth mindset research (Burnette et al., 2018) using a mental contrasting and implementation intentions (MCII) structure (Kirk et al., 2013). Section 1 was the same in both the experimental and control conditions, and Sects. 2–5 were specific to growth mindset of personality or athletic ability. The intervention content was designed to be engaging and age appropriate and included videos, quotes, images, and audio. Ten multiple choice questions were presented throughout the intervention to assess engagement and facilitate internalization of the content (see detailed intervention description in protocol).

2.4 Measures

2.4.1 Demographics

Demographic information was collected at the outset of the study, including the participant's self-reported age, gender, grade, academic level, ethnicity, and family's socioeconomic status. Gender was assessed using a single item which asked for participant's self-reported gender. Socioeconomic status was assessed using the Hollingshead index (Bornstein et al., 2002). Participants also completed a mental illness screener (single item) that asked whether they had been diagnosed with a mental illness, and if so, the specific disorder(s). Because the control intervention taught growth mindset of athletic ability, involvement in varsity athletics was also assessed (single item).

2.4.2 Depressive Symptoms (Primary)

Depressive symptoms were assessed using the Beck Depression Inventory (BDI-II; Beck et al., 1996), which consists of 21 items using a 4-point expanded rating scale from 0 to 3. The current study used only 20 items; as per ethics review, the item que-

[2] In some previous studies control conditions consisted of interventions that teach themes such as coping skills or sexual education. However, such control conditions have been criticized as a comparison for growth mindset interventions as it is possible that observed differences are the result of benefits of an optimistic message, rather than specifically teachings about growth mindset (Miu & Yeager, 2015). Thus, the current study used a conservative control that includes an optimistic message and a parallel format, but that had no theorized impact on outcomes of interest.

rying suicidal ideation was removed. Item scores were summed to determine summary scores from 0 to 60, such that higher scores indicate higher levels of depressive symptoms. The current sample had an $\alpha = 0.93$ at baseline.

2.4.3 Happiness (Primary)

Happiness (which represents the affective component of well-being) was measured using the Subjective Happiness Scale (SHS; Lyubomirsky & Lepper, 1999) to assess perceived personal experiences of overall happiness. This measure has four items rated on a 7-point Likert scale; responses are averaged to create a summary score and higher scores reflect higher levels of subjective happiness. The current sample had an $\alpha = 0.90$ at baseline.

2.4.4 Life Satisfaction (Primary)

Life satisfaction (which represents the cognitive component of well-being) was measured using the Brief Multidimensional Student Life Satisfaction Scale (BMSLSS; Seligson et al., 2003), which includes five items that assess global life satisfaction as a reflection of five life domains: family, school, friends, self, and living environment. The BMSLSS uses a 7-point Likert scale with higher scores representing higher levels of life satisfaction. The current sample had an $\alpha = 0.85$ at baseline.

2.4.5 Growth Mindset (Secondary)

The Implicit Personality Theory Questionnaire (IPTQ) (Erdley et al., 1997) was used to measure participants' growth mindset[3] of personality; specifically it measures the extent individuals believe one's personality can change. This three-item measure uses a 6-point Likert scale that ranges from strongly agree to strongly disagree and presents only *fixed* mindset items (e.g., You have a certain personality and it is something that you can't do much about). Higher scores on this measure were associated with higher levels of fixed mindset (i.e., lower growth mindset). The current sample had an $\alpha = 0.84$ at baseline.

Additionally, several growth mindset researchers have opted to use a general measure of beliefs about the capacity for a person to change overall (Dweck et al., 1995) to allow for non-specific assessment of beliefs that core attributes of a person can change. Although designed to assess beliefs that a person as a whole can change, this measure appears similar to the personality measure as it refers to "the kind of person someone is". Thus, the Implicit Person Theory Measure (IPTM) was also used to examine a generalized domain of growth mindset. This is a three-item measure with a 6-point Likert scale ranging from strongly agree to strongly disagree. Similar to

[3] Growth mindset has previously been named implicit theory because of the implicit nature of these beliefs, and as such measures use this previous terminology, however more recent research has returned to the term growth mindset because these beliefs are often made explicit through intervention (e.g., Schleider et al., 2020). In the clinical trials registration the term implicit theory was used to refer to growth mindset, and these are identified as secondary outcome measures. For this manuscript the term growth mindset is used as this is more consistent with current literature.

other measures, scores on each item were averaged, and higher average scores were associated with stronger fixed mindset beliefs (or lower growth mindset). The current sample had an $\alpha = 0.83$ at baseline.

To assess for differences in previous exposure to education on growth mindset, a single item measure was included that asked whether students have learned, or expect to learn about growth mindset at school. This was measured immediately prior to presentation of the intervention.

2.4.6 Engagement

Responses to the 10 multiple-choice questions within the intervention were summed to create a quantitative engagement score (*range* 0–10) used to evaluate participant engagement in the intervention. Written responses to the intervention were also qualitatively evaluated to assess engagement (using a procedure adapted from Yeager et al., 2016). Content analysis of responses was conducted by two coders using a simple binary coding procedure (see supplemental material for details), which coded responses as either 1) engaged: includes content related to the intervention, or 0) not engaged: does not include content related to the intervention.

2.5 Analysis Plan

Preliminary analyses involved the exploration of descriptive statistics, pre-intervention differences, correlations, tests of assumptions, transformations as necessary (see supplemental materials for details), and the assessment of outliers. Engagement was assessed both qualitatively and quantitatively using data collected in response to multiple choice knowledge questions and narrative responses integrated into the intervention. Randomization was assessed by comparing intervention conditions on baseline measures of age, gender, ethnicity, socio-economic status, and diagnostic status.

Primary analyses of the intervention used general linear models (GLM) to test for effects of time, condition, and interactions on growth mindset and outcomes of depressive symptoms, happiness, and life-satisfaction. Because of the strong relation between gender and primary outcomes (i.e., depressive symptoms, subjective happiness, and life satisfaction) established in previous literature (Crockett et al., 2020; Hankin, 2009) and replicated in this research (details in results), gender was included in these models via a 2 (time) x 2 (condition) x 2 (gender) mixed ANOVA. Although some previous work has included gender as a covariate in similar analyses, doing so accounts only for variability contributed to the independent variables (see supplement for details of the covariate analysis), thus in the present study gender was included as a fixed factor to directly explore its role in intervention effects. Due to the low number of students identifying as non-binary ($n = 3$), effects could not be assessed, and they were excluded from this analysis.

Planned comparisons were conducted to assess within-subjects effects across time and in each condition and gender. Patterns and effect sizes (Cohen's d) of paired comparisons were examined (calculated and interpreted using methods outlined by Lee, 2016: computed by mean difference divided by the standard error). Effect sizes represent mean change in primary and secondary outcome scores over time in each

intervention condition. Based on a-priori theory and pre-registration of hypotheses, paired comparisons were conducted for all variables whether or not interaction effects were identified in the Omnibus ANOVA.

2.6 Analytic Approach

Participants were retained if they participated at both baseline and follow up, even if determined to not have engaged with or completed the intervention. However, three participants who did not appear to even view the intervention, were removed from analyses. Further participants were removed prior to final analyses because their data were unusable (missing data prevented calculation of all outcome scores), a duplicated match (n = 1), data represented an outlier on an outcome measure ($n = 1$), or no data were present ($n = 4$). This study applied a per protocol approach (see flow diagram Fig. 1 for details). For remaining participants, if missing data prevented the calculation of a construct summary score, participants were deleted pairwise from analyses that used the missing construct (0–5% of cases in each measure). See protocol for details regarding missing data procedure.

Consistent with recommendations in psychological science to de-emphasize p-values and statistical significance (Wasserstein & Lazar, 2016; Wasserstein et al., 2019), in the current study, we include p-values as only one component that contributes to the meaningfulness of findings (Wasserstein et al., 2019). To interpret results we also consider the context of the study design and state of the literature (Betensky, 2019), combined with reporting of estimates and confidence intervals of effect sizes (Goodman et al., 2019; Krueger & Heck, 2019), and strong a priori theory (Krueger & Heck, 2019).

3 Results

3.1 Sample Characteristics

Parent consent forms were distributed to 2153 students in September 2019. Of 567 students who returned consent forms, 479 students attended for baseline data collection (October 2019), and 472 students were randomized. At four-months follow-up (February-March 2020), 69% of students returned (67% experimental, 71% control) indicating an overall attrition rate of 31%. Of those who attended the four months follow-up, 152 students in the experimental condition, and 166 students in the control condition were retained for analysis for a total of 318 participants (See CONSORT flow, Fig. 1). Sample characteristics and differences between conditions are described in Table 1; participants had a mean age of 15 years (65% grade 9, 34% grade 12), were 58% girls, 61% white/European ethnicity, 91% were in the "academic" stream of the Ontario curriculum[4], and 91% reported no previous mental illness diagno-

[4] In the Ontario curriculum students are enrolled such that they are streamed toward various post-secondary outcomes. "Academic" level suggests students are bound for university after high school, "Applied" suggests students are bound for college, "Essential" suggests students are bound for the work force, and "Life skills" suggests teaching students basic life skills. See Table 1 for breakdown of students in each stream.

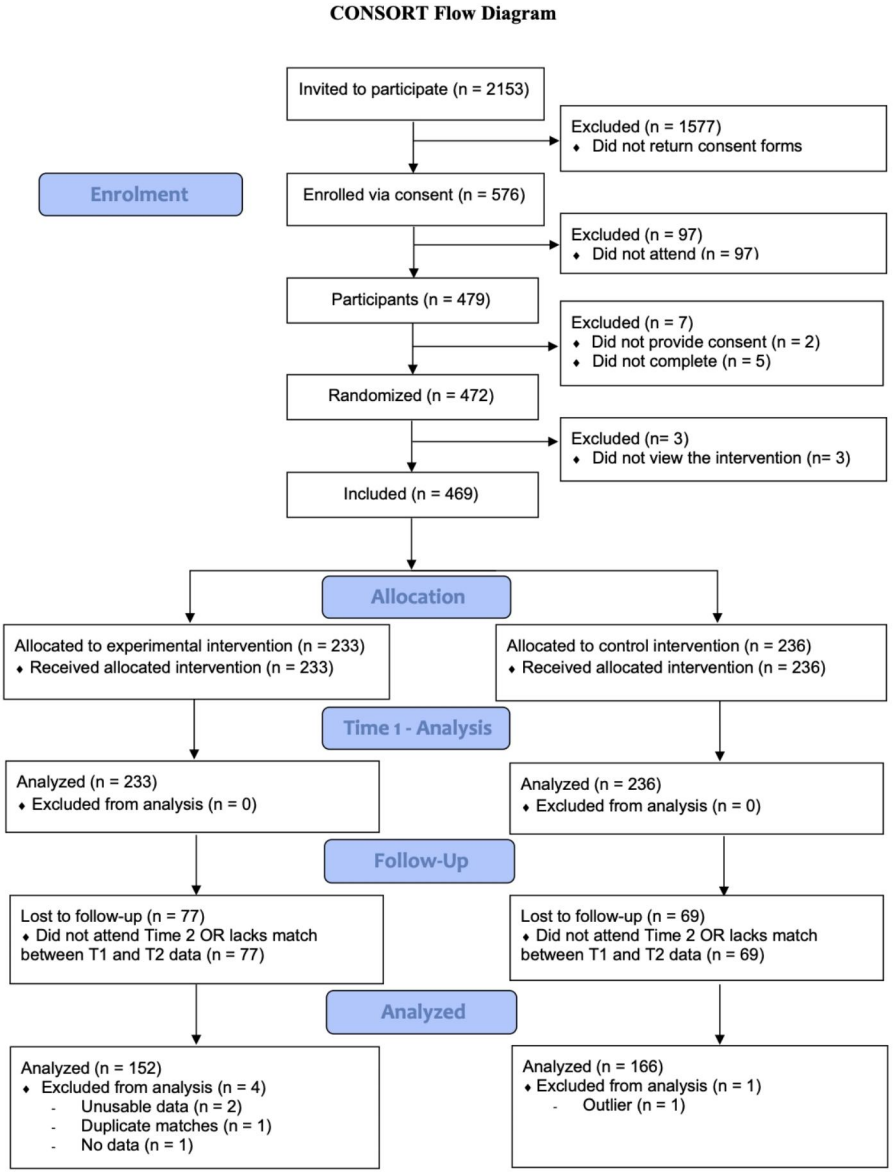

Fig. 1 CONSORT diagram of the flow of participants through the study

Table 1 Demographics of study participants, and differences between conditions at baseline

		Overall	Personality	Athletic	Difference		
		$n=318$	$n=152$	$n=166$	F	Chi X	p
Age (years)	Mean (SD)	14.89 (1.54)	14.93 (1.56)	14.86 (1.53)	0.174		0.677
Gender						0.866	0.834
	Female	184 (57.9%)	86 (56.6%)	98 (59.0%)			
	Male	128 (40.3%)	63 (41.4%)	65 (39.2%)			
	Gender fluid/non-binary	3 (0.9%)	1 (0.7%)	2 (1.2%)			
	Did not identify	3 (0.9%)	2 (1.3%)	1 (0.6%)			
Grade						2.116	0.549
	9	205 (64.5%)	98 (64.5%)	107 (64.5%)			
	10	1 (0.3%)	0 (0.0%)	1 (0.6%)			
	11	4 (1.3%)	3 (2.0%)	1 (0.6%)			
	12	108 (34.0%)	51 (33.6%)	57 (34.3%)			
Academic						3.504	0.173
Level	Academic	289 (90.9%)	143 (94.1%)	146 (88.0%)			
	Applied	27 (8.5%)	9 (5.9%)	18 (10.8%)			
	Essential	0 (0.0%)	0 (0.0%)	0 (0.0%)			
	Life Skills	1 (0.3%)	0 (0.0%)	1 (0.6%)			
	Did not report	1 (0.3%)	0 (0.0%)	1 (0.6%)			
SES					0.161		0.689
(Hollings-head rating 1–9)	Mean (SD)	5.74 (1.97) ($n=284$)	5.69 (1.94) ($n=135$)	5.79 (2.01) ($n=149$)			
Mental Illness						10.484	0.163
	No Diagnosis	289	133	156		2.246	0.134
	Depression (inc. comorbid)	(90.9%)	(87.5%)	(94.0%)			
	Comorbid Conditions	15	10 (6.6%)	5 (3.0%)			
	Anxiety	(4.7%)	11 (7.2%)	5 (3.0%)			
	ADHD	16	5 (3.3%)	0 (0.0%)			
	Depression (sole diagnosis)	(5.0%)	1 (0.7%)	1 (0.6%)			
	OCD	5 (1.6%)	1 (0.7%)	1 (0.6%)			
	Eating Disorder	2 (0.6%)	0 (0.0%)	1 (0.6%)			
	Autism/Asperger's	2 (0.6%)	1 (0.7%)	1 (0.6%)			
	Learning Disability	1 (0.3%)	0 (0.0%)	0 (0.0%)			
		2 (0.6%)	0 (0.0%)	1 (0.6%)			
		0 (0.0%)					
		1 (0.3%)					
Ethnicity						11.531	0.318
	White/European	193 (60.7%)	97 (63.8%)	96 (57.8%)			
	Southeast Asian	53 (16.7%)	28 (18.4%)	25 (15.1%)			
	South Asian	30 (9.4%)	13 (8.6%)	17 (10.2%)			

Table 1 (continued)

		Overall $n=318$	Personality $n=152$	Athletic $n=166$	Difference F	Chi X	p
	Multiple Ethnicities	16 (5.0%)	3 (2.0%)	13 (7.8%)			
	West Asian	8 (2.5%)	5 (3.3%)	3 (1.8%)			
	Black/African/Caribbean	8 (2.5%)	2 (1.3%)	6 (3.6%)			
	Arab	3 (0.9%)	1 (0.7%)	2 (1.2%)			
	Latin American	3 (0.9%)	2 (1.3%)	1 (0.6%)			
	Indigenous	2 (0.6%)	1 (0.7%)	1 (0.6%)			
	West Indian	1 (0.3%)	0 (0.0%)	1 (0.6%)			
	Did not report	1 (0.3%)	0 (0.0%)	1 (0.6%)			
Growth mindset						6.389	
	Had exposure	132 (41.5%)	52 (34.2%)	80 (48.2%)			
	No previous exposure	186 (58.5%)	100 (65.8%)	86 (51.8%)			
Varsity Athletics						0.133	0.715
	Varsity Athlete	89 (28.0%)	44 (28.9%)	45 (27.1%)			
	No Varsity Athletics	229 (72.0%)	108 (71.1%)	121 (72.9%)			

sis. No significant differences in demographics or involvement in varsity athletics were identified between conditions at baseline (see Table 1). There was, however, a difference between conditions in their previous exposure to growth mindset, such that fewer students in the experimental condition (34.2%) had exposure to previous teaching about growth mindset than in the control condition (48.2%). Any impact of this initial difference would only have a more conservative impact on results, and thus was not interpreted further. Similarly, no significant differences in primary or secondary outcomes were identified between conditions at baseline (see details in supplemental materials Table S1).

3.2 Preliminary Analyses

Examination of correlations between outcomes as well as tests of assumptions were conducted, and are available in the supplemental materials.

3.2.1 Engagement

Participants correctly answered an average of 9.96 ($SD=0.26$) out of 10 embedded questions and 94% of students wrote about content related to the intervention's teaching (Cohen's $\kappa=0.73$). The correlation between quantitative and qualitative engagement measures was $r=.37$, $p<.001$, suggesting overlap across the two methods of engagement evaluation. Taken together, findings suggest students were appropriately engaged in the intervention.

3.3 Effects of Intervention on Mindset (Secondary Outcomes)

Effects of the intervention on measures of mindset were assessed using 3 (time) by 2 (condition) mixed ANOVAs via GLM and planned paired comparisons (see Table 2. Analyses indicated a main effect of time on mindset of personality [$F(2, 618) = 104.632$, $p < .001$, $\eta^2 = 0.254$)], and general mindset [$F(2, 616) = 97.688$, $p < .001$, $\eta^2 = 0.241$], with large effect sizes. There was no main effect of condition on mindset of personality [$F(2, 618) = 2.948$, $p = .087$, $\eta^2 = 0.009$], or general mindset [$F(2,616) = 0.168$, $p = .682$, $\eta^2 = 0.001$]. As hypothesized, a small interaction effect of time x condition on mindset of personality [$F(3, 616) = 7.603$, $p < .001$, $\eta^2 = 0.024$], and general mindset [$F(3, 614) = 7.413$, $p = .001$, $\eta^2 = 0.024$] was observed. Examination of planned paired comparisons showed that from baseline to immediately post intervention endorsement of both personality and general growth mindset increased (see Table 2) with a large effect in the experimental condition, and a medium effect in the control condition. From baseline to 4-months follow-up paired comparisons showed an increase in endorsement of both personality and general growth mindset in the experimental condition, and in the control condition only an increase of endorsement of personality growth mindset, with no change in general growth mindset.

3.4 Effects of Intervention on Primary Outcomes

Effects of the intervention on outcomes of depressive symptoms, perceived happiness, and life satisfaction were assessed using 2 (time) x 2 (condition) x 2 (gender) mixed ANOVAs via GLM and planned paired comparisons.

3.4.1 Depressive Symptoms

Analyses indicated no main effect of time or condition on depressive symptoms, as well as no 2-way interaction effects (between time and condition, time and gender, or gender and condition). However, it is notable that the 2-way time x condition effect [$F(1,308) = 3.414$, $p = .066$, $\eta^2 = 0.011$] given the effect approaches significance. Analyses indicated a large size main effect of gender [$F(1,308) = 20.548$, $p < .001$, $\eta^2 = 0.063$], as well a small size three-way interaction effect between time, condition, and gender [$F(1,308) = 6.807$, $p = .01$, $\eta^2 = 0.022$] (see Table 3), which indicated that depressive symptoms from baseline to follow-up differed between the experimental versus control condition, and patterns differed between genders (see Fig. 2). Examination of planned paired comparisons of simple effects (see Table 4) showed no changes in depressive symptoms in either the control or experimental condition for boys. However, for girls, depressive symptoms increased in the control condition (M_{diff} = -1.451, $p = .046$, $d = -0.203$, 95%CI [-0.087, 0.493]), and decreased in the experimental condition ($M_{diff} = 2.221$, $p = .004$, $d = 0.311$, 95%CI [0.019, 0.602]).

3.4.2 Happiness

Analyses indicated no main effect of time, no 2-way interaction effects (between time and condition, time and gender, or gender and condition), and no 3-way interac-

Table 2 Means and paired comparisons of mindset measures across baseline, immediately post-intervention, and at 4-months follow up within each condition (pairwise deletion, two tailed, and Bonferroni corrections)

		Mean (SD)			Paired Comparisons				
	Total *N*	Baseline	Post- intervention	4-months follow up	Comparison	Mean difference	*SE*	*p*	*d*
IPTQ					Baseline to post-intervention				
Athletic	160	3.36 (1.20)	2.68 (1.14)	3.09 (1.08)	Athletic	0.677	0.080	0.00***	0.669
Personality	150	3.34 (1.14)	2.22 (0.96)	3.05 (1.10)	Personality	1.120	0.082	0.00***	1.115
					Baseline to 4-months follow up				
					Athletic	0.267	0.094	0.015*	0.225
					Personality	0.296	0.097	0.008**	0.249
IPTM					Baseline to post-intervention				
Athletic	158	3.31 (1.17)	2.71 (1.09)	3.12 (1.12)	Athletic	0.559	0.080	0.00***	0.556
Personality	151	3.49 (1.15)	2.43 (0.98)	3.10 (1.00)	Personality	1.062	0.082	0.00***	1.054
					Baseline to 4-months follow up				
					Athletic	0.192	0.086	0.077	0.178
					Personality	0.389	0.088	0.00***	0.360

*$p<.05$, **$p<.01$, ***$p<.001$

Note: IPTQ = Implicit Personality Theory Questionnaire; IPTM = Implicit Person Theory Measure.

Table 3 Main effects and interactions of primary outcomes from baseline to 4-months follow up

	Effect	*F*	*p*	η^2
BDI				
	Time	0.062	0.804	0.000
	Condition	0.258	0.612	0.001
	Gender	20.548	<0.001***	0.063
	Time * Condition	3.414	0.066	0.011
	Time * Gender	0.472	0.492	0.002
	Condition * Gender	0.615	0.433	0.002
	Time * Condition * Gender	6.807	0.010*	0.022
SHS				
	Time	0.270	0.604	0.001
	Condition	3.910	0.049*	0.013
	Gender	6.532	0.011*	0.021
	Time * Condition	1.469	0.226	0.005
	Time * Gender	0.013	0.909	0.000
	Condition * Gender	0.516	0.473	0.002
	Time * Condition * Gender	0.243	0.623	0.001
BMSLSS				
	Time	3.637	0.057	0.012
	Condition	1.025	0.312	0.003
	Gender	13.686	<0.001***	0.043
	Time * Condition	2.986	0.085	0.010
	Time * Gender	0.002	0.964	0.000
	Condition * Gender	0.159	0.691	0.001
	Time * Condition * Gender	0.000	0.990	0.000

*$p<.05$, **$p<.01$, ***$p<.001$

Note: Participants who identified as non-binary or did not identify their gender *(n*=6) could not be considered a separate group and were removed from these analyses. BDI=Beck Depression Inventory; SHS=Subjective Happiness Scale; BMSLSS=Brief Multidimensional Student Life Satisfaction Scale.

tions effects (between time, condition, and gender) on subjective happiness (Table 3). Further, planned paired comparisons were conducted based on a-priori theory, and indicated no differences in subjective happiness between baseline and 4-months follow-up, for girls or boys, in either condition (Table 4), and thus no meaningful impact of the intervention on subjective happiness (see Fig. 2).

Notably, a small main effect of gender [$F(1,306)=6.532$, $p=.011$, $\eta^2=0.021$] on subjective happiness was identified, which suggests that overall girls evidenced lower subjective happiness than boys. Additionally, a small main effect of condition [$F(1,306)=3.910$, $p=.049$, $\eta^2=0.013$] on subjective happiness was identified, which indicates that those in the control condition reported lower subjective happiness than those in the experimental condition across time points.

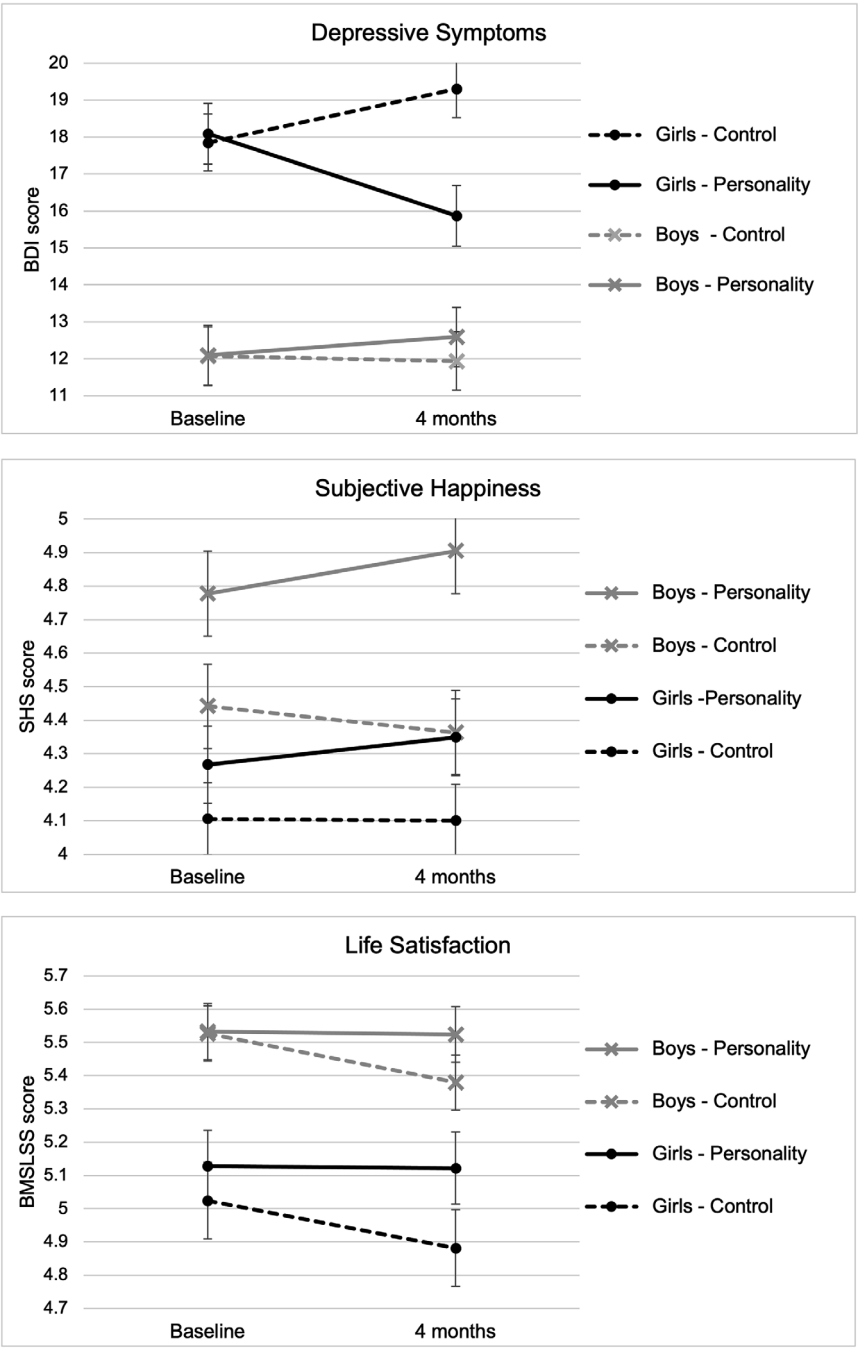

Fig. 2 Primary outcomes (depressive symptoms, subjective happiness, and life satisfaction) from baseline to 4-months follow up between condition, and gender. Error bars are the standard error of the mean difference between baseline and 4-months follow up. The personality condition is represented by a solid line, the control condition is represented by a dashed line

Table 4 Means and paired comparisons of primary outcome measures across baseline and 4-months follow up within each condition and gender (pairwise deletion, two tailed, and Bonferroni corrections)

			Mean (SD)		Paired Comparisons			
	Condition	Total *N*	Baseline	4-Months follow up	Mean difference	*se*	*p*	*d*
BDI								
Boys	Control	65	12.07 (9.27)	11.94 (10.39)	0.133	0.887	0.881	0.019
	Personality	63	12.10 (9.72)	12.59 (12.62)	-0.494	0.901	0.584	-0.069
Girls	Control	98	17.85 (10.85)	19.30 (12.72)	-1.451	0.722	0.046*	-0.203
	Personality	86	18.09 (11.68)	15.87 (11.84)	2.221	0.771	0.004**	0.311
SHS								
Boys	Control	64	4.44 (1.48)	4.36 (1.54)	0.078	0.13	0.549	0.075
	Personality	63	4.78 (1.48)	4.90 (1.51)	-0.127	0.131	0.334	-0.122
Girls	Control	97	4.11 (1.55)	4.10 (1.50)	0.005	0.106	0.961	0.005
	Personality	86	4.27 (1.50)	4.35 (1.42)	-0.081	0.112	0.469	-0.078
BMSLSS								
Boys	Control	65	5.53 (0.97)	5.38 (1.00)	0.147	0.086	0.087	0.220
	Personality	63	5.53 (1.03)	5.52 (1.15)	0.008	0.087	0.923	0.012
Girls	Control	97	5.02 (1.22)	4.88 (1.19)	0.143	0.07	0.043*	0.207
	Personality	86	5.13 (1.11)	5.12 (1.09)	0.006	0.075	0.938	0.009

*$p<.05$, **$p<.01$, ***$p<.001$

Note: Participants who identified as non-binary or did not identify their gender *(*$n=6$) could not be considered a separate group and were removed from these analyses. BDI = Beck Depression Inventory; SHS = Subjective Happiness Scale; BMSLSS = Brief Multidimensional Student Life Satisfaction Scale.

3.4.3 Life Satisfaction

Analyses indicated no main effect of time or condition on life satisfaction, no 2-way interaction effects (between time and condition, time and gender, or gender and condition), and no 3-way interactions effects (between time, condition, and gender) (Table 3). However it is notable that a small main effect of time may be meaningful [$F(1,307)=3.637$, $p=.057$, $\eta^2=0.012$], suggesting an overall decrease in life satisfaction over time.

Importantly, findings indicated a medium main effect of gender [$F(1,307)=13.686$, $p<.001$, $\eta^2=0.043$] such that girls reported lower life satisfaction than boys overall.

Interestingly, examination of the planned paired comparisons showed a reduction in life satisfaction for girls between baseline and 4-months follow-up in the control condition with a small effect size ($M_{diff}=0.143$, $p=.043$, $d=0.207$, 95% CI [-0.084, 0.489]), and in contrast, no change in life satisfaction over time in the experimental condition (Table 4). This pattern in paired comparisons may indicate a small positive protective effect of the experimental intervention on life satisfaction in girls, however findings are interpreted conservatively considering the omnibus results and may suggest the effect is relatively weak (see Fig. 2).

4 Discussion

This study examined how a 30-minute single session online intervention that taught growth mindset of personality affected the mindset beliefs, depressive symptoms, and well-being of a community high school sample of 318 adolescents over a 4-month period. Both the personality condition (which taught that personalities are not fixed and can change and grow) and the active control condition (which taught growth mindset of athletic ability with an equally positive message) were evidenced to be engaging and increased endorsement of growth mindset beliefs immediately post intervention, with larger effects in the personality condition. Effects were maintained over four months (albeit with small effect sizes). Consistent with previous literature, gender had an independent main effect on all primary outcomes (depressive symptoms, subjective happiness, and life satisfaction), such that across time and condition girls reported substantially higher depressive symptoms, and lower life satisfaction and subjective happiness than boys. Results suggest that gender is the strongest and most consistent predictor of primary outcomes in this study. Interestingly, however, gender appeared to interact with the intervention's impact on depressive symptoms. In particular, girls reported decreased depressive symptoms at follow-up, indicating a responsiveness to the intervention, that was not seen in boys. For outcomes of well-being, the growth mindset of personality intervention showed an inconclusive, protective effect on life satisfaction in girls that warrants further exploration, and did not affect ratings of subjective happiness.

4.1 Mindset Beliefs

Consistent with previous research (Aronson et al., 2002; Burnette et al., 2018; Schleider et al., 2020) and hypotheses, the personality condition led to a large increase in endorsement of growth mindset beliefs of personality immediately post-intervention. After 4 months, changes to mindset beliefs had diminished but were still meaningfully different, which is also consistent with previous findings (Burnette et al., 2018; Blackwell et al., 2007; Schleider et al., 2020). As hypothesized, for participants in the personality condition, endorsement of general growth mindset beliefs followed a similar pattern. Although most previous research suggests that growth mindset teachings are domain specific (Yeager & Dweck, 2012), the personality and general measures of growth mindset share similarities, and current findings indicate that the content of growth mindset of personality interventions could lead to a generalization of growth mindset beliefs.

In contrast to hypotheses and established theory about domain specificity, the control condition also increased endorsement of growth mindset of personality beliefs immediately post intervention, albeit with a weaker effect than the personality condition, and participants demonstrated a weaker yet still meaningful increase in endorsement of growth mindset of personality from baseline to 4-months follow-up. However, this change did not persist for the general growth mindset measure, possibly suggesting that the teachings of the control condition (growth mindset of athletic ability) were not generalized in the same way as the teachings of the personality condition. Again, this pattern of results suggests potentially more salience

of the teachings of growth mindset of personality. Alternatively, participants in the control condition may have been providing socially desirable responses by applying teachings to the personality and general growth mindset measures, as no measure of the athletic domain was evaluated. Unfortunately, previous research that used growth mindset of athletics as a control did not examine change in growth mindset beliefs (Miu & Yeager, 2015), making this a novel finding. Further research is needed to better delineate the implications of such a control condition on growth mindset beliefs.

In contrast to previous research (Schleider & Weisz, 2016a), the current study found no difference of growth mindset measures between genders at baseline. The previous research measured growth mindset in the domain of thoughts, feelings, and behaviours in students aged 11–14, unlike the current study which measured growth mindset in the domain of personality in students aged 13–18. This difference observed as a function of measurement focus may suggest that growth mindset beliefs about personality do not differ between genders as they do in other measures, or that gender differences in mindset (personality related) are less pronounced as adolescents develop. Regardless, further research in this area is needed.

4.2 Depressive Symptoms

The current results showed a reduction in depressive symptoms after 4 months after the single session 30 min personality growth mindset intervention in girls compared to a slight increase in depressive symptoms for girls in the control condition; no similar changes were observed in boys. Noteably, at baseline, the mean depressive symptom score for girls fell in the mild clinical range. And although mean depressive syptoms in both conditions remained in this same clinical range at follow up, groups meaningfully diverged. The mean of the control condition reached the upper end of the mild clinical range, and the mean of the personality condition fell closer to the lower end of the mild clinical range. Athough small, these change in depressive symtoms in girls are statistically significant, and are similar in magnitude to that of other studies using similar methods and measures (Schleider & Weisz, 2018). Further, recent meta-analytic findings suggest that effect sizes between 0.10 and 0.20 are "within a reasonable.

benchmark for expected effects" for such interventions. Although the findings in girls align with similar interventions (Miu & Yeager, 2015; Schleider et al., 2020; Schleider & Weisz, 2018), and with meta-analytic findings of the relation between psychological distress and growth mindset beliefs (Burnette et al., 2020), the differing impacts of the intervention between genders is novel and may have important implications.

Previous research clearly indicates that gender plays an important role in the development of depressive symptoms in adolescence (Hankin, 2009). Indeed, in our sample, girls reported substantially higher rates of depressive symptoms than did boys at baseline, and showed a slight increase in depressive symptoms in the control condition over time. A meta-analysis of the relation between growth mindset and mental health outcomes was unable to assess potentially differing patterns between genders, and suggested exploration in future work (Schleider et al., 2015). A recent meta-analysis emphasized the important of assessing for moderators to better determine

for whom growth mindset interventions are most effective (Burnette et al., 2022). However, most previous work examining the effect of growth mindset interventions on depressive symptoms has *controlled* for gender but has not directly examined differing impacts on boys and girls, leading to gender being *accounted* for, but not *directly examined*. In one growth mindset of personality intervention study, gender differences were explored in a sample of students entering high school (grade 9 only), but no interaction between condition and gender was included in the analyses (Miu & Yeager, 2015). Similarly, in a study of a growth mindset of personality intervention in at risk youth age 12–15, gender was included as a covariate (along with age, and family structure) but not identified as a significant predictor of youth reported depressive symptoms in a model with time and condition (Schleider & Weisz, 2018). In both of these samples, participants were younger than those in the current study and in the latter study had previously identified symptoms of depression or anxiety. It is possible that gender differences observed in the current study emerge later in adolescence as girls and boys continue to diverge, and may also be most identifiable in an unselected samples rather than samples targeting at risk youth. Because gender differences have not been thoroughly examined in previous work, it is possible that effects seen in combined samples of older adolescents in previous research is driven primarily by girls.

One study that focused exclusively on adolescent girls found a reduction in depressive symptoms at 4-months follow-up after a growth mindset intervention targeting mindsets related to personality, intelligence, self-regulation (Schleider et al., 2020). This work taken together with the current findings suggest a promising impact of growth mindset of personality interventions in the prevention of depression for girls specifically. For boys, baseline differences may have led to a floor effect, such that change could not be measured. Although boys reported lower depressive symptoms compared to girls, the average depressive symptoms reported by boys may still be clinically relevant as the baseline mean fell just below the clinical cut off, especially since subthreshold depression is associated with negative outcomes and later development of depression (Balazs et al., 2013; Klein et al., 2009). Thus the depressive symptoms reported by boys in this sample are still a worthy target of preventative efforts.

Our findings suggest that adolescent boys may not be benefiting from growth mindset interventions (as currently constructed) in the same ways girls appear to be. One explanation for this difference, is the well-estabished differences in social roles and value orientations between boys and girls. Blatt and Zuroff (1992) classically argued that girls (vs. boys) tend to be higher in sociotropy (i.e., value of and motivation towards social relationships) whereas boys may be higher than girls in autonomy (i.e., value of and motivation towards independence and self-esteem), a tendency supported by evidence (see Yang & Girgus, 2019 for meta-analysis and review). These value orientations have been theorized to play an important role in the development of depression in adolescence (see Blatt & Zuroff, 1992 for review). Those with sociotropic tendencies are particularly affected by others, and may experience sociotropic depression when they experience perceived social losses or rejection. The content of the current intervention (and most growth mindset of personality interventions) teaches the belief that socially relevant characteristics can change. This particular

focus may thus be more relevant to girls, and align with the sociotropic prototype of depression more common in women and girls.

Further research on the differential effectiveness of growth mindset interventions on boys and girls is worthy of attention, including identifying which aspects of interventions are more or less effective with boys in particular, and possibly considering how to apply growth mindset to values aligned with an autonomous prototype of depression more common in boys. Notably, some previous studies included specific populations at risk for experiencing depression (Miu & Yeager, 2015; Schleider et al., 2020; Schleider & Weisz, 2018) and as such may have seen more pronounced effects than those observed in our broad and unselected sample of adolescents attending public school. Taken together, current finding are promising, and add to the growing literature suggesting such interventions can have a meaningful effect on depressive symptoms in adolescence.

4.3 Well-Being as Indexed by Happiness and Life Satisfaction

Inconsistent with hypotheses, the intervention showed no effect on subjective happiness over the follow-up period, and endorsement of happiness in both boys and girls remained similar from baseline to follow-up. However, analyses of life satisfaction showed an inconclusive effect of intervention; no 2 or 3-way interactions were identified, but a priori paired comparisons indicated a small protective effect in girls, such that girls in the control condition showed a decline in life satisfaction over 4-months follow-up, while those in the experimental condition endorsed stable life satisfaction ratings. Given the lack of statistically significant interactions, these findings are inconclusive and should be interpreted cautiously, thus requiring further investigation. Similar to established patterns of well-being in adolescence (González-Carrasco et al., 2017), boys in our sample reported higher levels of happiness and life satisfaction at baseline than girls. These baseline differences seemed not to impact intervention effects on happiness (as it did with depressive symptoms), but did seem to have a possible impact in intervention effects on life satisfaction. Overall, findings were inconclusive regarding the impact of teaching a growth mindset of personality on life satisfaction but warrant further examination particularly among girls, and currently indicate no impact on subjective happiness.

There may be a number of explanations for these mixed findings. First, findings could indicate that teaching growth mindset of personality impacts cognition but may not impact affective experience. Such interventions focus on changing thoughts and beliefs, which may not align with the affective nature of subjective happiness, and instead are more impactful in cognitive appraisals of life satisfaction. Second, well-being is composed of many separable facets (Diener et al., 2017) and the well-being measures in the current study covered a broad conceptualization of well-being. The current growth mindset intervention is focused on beliefs in one domain of life, and as such the measures used in the current study may have been too broad to detect changes in life satisfaction and well-being in peer relations in particular. Future research may benefit from examining more targeted measures of well-being in similar designs. Despite these challenges, we argue that these findings on life satisfaction in girls may align with previous findings of protective effects on depressive symp-

toms (Miu & Yeager, 2015), and that further study is warranted to determine whether growth mindset interventions have potential for broader impacts on important youth outcomes.

4.4 Limitations & Future Directions

Although there were several strengths of the current study including the RCT design, engaging intervention content, assessment of gender, and inclusion of well-being outcomes, some limitations require note. The current sample was composed of largely university bound (designated "academic" level in the Ontario curriculum), majority white/European students living in Ontario Canada, which limits generalizability to other populations. However, examining effects in a non-selected public school sample is also a strength as this may be representative of future scaled-up broad administration in educational settings, and allows for conservative estimates of effects. Due to the differing findings between girls and boys, and limited effects on depressive symptoms in boys specifically, future intervention studies may benefit from seeking to better understand how to engage at-risk boys in particular. Towards these ends, future research may benefit from explorations with adolescents who are consuming these interventions to determine which aspects of interventions speak to them and also what may be missing the mark, particularly for boys.

Consistent with previous growth mindset research (Schleider et al., 2020; Burnette et al., 2018), the current study used a 4-months follow-up, however longer follow-up periods (similar to Miu & Yeager, 2015; Schleider & Weisz, 2018; Yeager et al., 2013) or preferably longitudinal designs with multiple follow-up points would add to the understanding of long term effects of these interventions.

As is common in preventative single-session interventions for depressive symptoms (Schleider & Weisz, 2017, 2018), the current study demonstrated modest effect sizes. However, modest effects can be quite meaningful at the population level (Chisholm et al., 2004). Further, even small changes in adolescence can have cascading implications into adulthood (see Cicchetti & Hinshaw, 2002; Masten & Cicchetti, 2010 for discussion).

In the context of a brief online intervention, our findings contribute to the growing evidence that provides promise for the future dissemination of similar low cost interventions via schools to protect against typical increases seen in depressive symptoms. The current intervention was similar to other growth mindset interventions in the mental health domain (i.e., single session, 30 min length), and aligned with most recommendations for high-fidelity implementation identified in recent meta-analysis. Effect sizes herein were within or above the expected range for such interventions on target groups (Burnette et al., 2022). This study contributes to the growing body of evidence of the benefits of growth mindset interventions; and still, replication of interventions in various populations to build towards capacity for high quality meta-analyses of similar intervention studies is needed.

5 Conclusions

Adolescence marks a period of heightened risk for depressive symptoms and disorder (Merikangas et al., 2010), and diminished well-being (González-Carrasco et al., 2017). Continued exploration of engaging and accessible preventative approaches that limit the impact of these changes, such as single-session online interventions, are needed to address this growing concern. The current study found that a brief single-session online intervention that taught growth mindset of personality led to reduced symptoms of depression in girls, and indicates further exploration of possible protective effects for girls against typical reductions in life satisfaction is warranted. Although findings were modest, the preventative nature of the intervention suggests it may still have clinical and public health relevance. Future replication is needed, preferably with domain specific measures of well-being, additional follow-up time points, and exploration of how best to meet needs of boys. The current work adds to the mounting literature in the area of growth mindset interventions in youth, and highlights the importance of considering gender as a factor influencing effects of such intervention.

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Declarations

Conflict of Interest No conflicts declared.

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