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Preliminary Evaluation of a Single Brief Session of a Novel Gamified Attentional Bias Modification for Improving Children's Happiness: Randomized Controlled Trails

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Preliminary Evaluation of a Single Brief Session of a Novel Gamified Attentional Bias Modification for Improving Children's Happiness: Randomized Controlled Trails

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Abstract

Background: Previous research has shown significant effect of gamified attentional bias modification on negative affect. However, insufficient studies have investigated the effect of gamified attentional bias modification on improving positive affect.

Objective: The study assessed the effect of novel gamified attentional bias modification on self-report positive attentional bias and subjective happiness.

Methods: Adolescents from a secondary school in Hong Kong were recruited and randomly assigned into three conditions which were negative-avoidance attentional bias modification, the combination of negative-avoidance and positive-search attentional bias modification, and placebo training. After completing the inventories to assess positive attentional bias and subjective happiness, participants engaged in a 15-minute short training session. They completed the second assessment of positive attentional bias and subjective happiness immediately after the session.

Results: None of the conditions significantly improved self-report positive attentional bias and subjective happiness from Time 1 to Time 2. No difference was found among the training conditions.

Conclusions: indings suggested that a single brief session of gamified ABM was not sufficient in inducing changes in self-report positive attentional bias and subjective happiness. Adding positive-search attentional bias modification to negative-avoidance attentional bias modification did not significantly increase the effect of ABM training on self-report positive attentional bias and subjective happiness. The study implied that gamified ABM might not be an ideal attentional training for improving adolescents' happiness.

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Abstract

Background. Previous research has shown a significant effect of gamified attentional bias modification on negative affect. However, insufficient studies have investigated the effect of gamified attentional bias modification on improving positive affect. **Objective.** The study assessed the effect of novel gamified attentional bias modification on self-report positive attentional bias and subjective happiness. **Method.** Adolescents from a secondary school in Hong Kong were recruited and randomly assigned to three conditions which were negative-avoidance attentional bias modification, the combination of negative-avoidance and positive-search attentional bias modification, and placebo training. After completing the inventories to assess positive attentional bias and subjective happiness, participants engaged in a 15-minute short training session. They completed the second assessment of positive attentional bias and subjective happiness immediately after the session. **Results.** None of the conditions significantly improved self-report positive attentional bias and subjective happiness from preassessment to postassessment. No difference was found among the three training conditions. **Conclusion.** Findings suggested that a single brief session of gamified ABM was not sufficient in inducing changes in self-reported positive attentional bias and subjective happiness. Adding positive-search attentional bias modification to negative-avoidance attentional bias modification did not significantly increase the effect of ABM training on self-report positive attentional bias and subjective happiness.

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Introduction

Attentional Biases and Attentional Bias Modification

The cognitive theory of anxiety emphasizes the role of cognitive factors in the development of anxiety and related disorders, which has ignited a passion for investigating maladaptive cognitive processes in anxious individuals. One of the cognitive vulnerabilities in anxious individuals is attentional bias. Based on Eysenck, Derakshan, Santos, and Calvo's (2007) cognitive model of anxiety, attentional bias is the consequence of deficits in the top-down executive control systems, causing difficulty in shifting and inhibiting attention to threatening stimuli.

The important role of attentional bias in the development and maintenance of anxiety has served as an impetus for the creation of a novel digital intervention--attentional bias modification (ABM; K. Mogg, Waters, & Bradley, 2017). ABM is developed from some of the commonly used experimental paradigms in the measurement of attentional bias. In ABM adopted from the visual probe paradigm, participants are instructed to view a computer screen where a threatening stimulus and a non-threatening stimulus will display on two opposite positions on a screen. Then, a probe will appear always on the positions of the non-threatening stimulus shortly after the offset of the two stimuli. Patients are asked to respond to the stimulus by pressing a key as quickly as possible. It is expected that attentional bias will be modified when the participants are trained to attend to the non-threatening stimulus and avoid the threatening stimulus. The visual search task version of ABM trains patients to selectively search for a benign stimulus in the presence of various threatening stimuli. It is believed that the training can help patients form a habit to selectively attend to positive stimuli without being distracted by concurrent threatening stimuli.

Two Approaches of Attentional Bias Modification

The two major approaches of ABM are negative-avoidance ABM and positive-search ABM. Negative-avoidance ABM adopts the dot-probe paradigm, while positive-search ABM invariantly uses the visual-search paradigm (Mogg & Bradley, 2016). The rationale of negative-avoidance ABM is that anxious people can be trained to automatically shift attention away from threatening stimuli, which reduces negative attentional bias and anxiety. In accordance with the integrative model of anxiety, the salience-driven bottom-up system is more sensitive to threats in anxious individuals, resulting in automatic orienting to threats. Negative-avoidance ABM may be effective in altering this bottom-up orienting to threat, occurring at the early stage of information processing by training people to automatically avoid attending to threats; consequently, negative-avoidance ABM relieves attentional bias towards threats. However, one weakness of negative-avoidance ABM lies in its capacity to improve weakened efforful cognitive control in anxious people (Mogg & Bradley, 2016).

In positive-search ABM, participants are trained to voluntarily allocate their attention to positive stimuli among a bunch of negative distractors (Waters et al., 2015). Based on the integrative model of anxiety, positive-search ABM may be more able to strengthen the later top-down information processing system than negative avoidance ABM (Mogg & Bradley, 2016). Thus, positive-search ABM may be superior to negative-avoidance ABM in balancing the bottom-up and top-down information processing system in anxious individuals. As a result, positive-search ABM not only trains participants to shift attention from threatening stimuli but also to increase their effortful cognitive control of attention towards positive stimuli (Mogg & Bradley, 2016).

The Relationship of Attentional Biases to Positive Affect

Previous research has shown that training facilitating avoidance of negative thoughts helps improve mental health (Mamat & Anderson, 2023). A multitude of research has been conducted on the efficacy of negative avoidance ABM in reducing negative affect. Some studies found promising outcomes of ABM-negative-search (Amir et al., 2009; Beard, Sawyer, & Hofmann, 2012; Lazarov et

al., 2018; Linetzky, Pergamin-Hight, Pine, & Bar-Haim, 2015; L.-y. Liu, Wang, & Qing, 2015; Teng, Hou, Chang, & Cheng, 2019). Others found the effect of ABM-negative-search was small to non-significant (Dennis-Tiwary, Denefrio, & Gelber, 2017; Heeren, Mogoaşe, Philippot, & McNally, 2015; H. Liu, Li, Han, & Liu, 2017; Mogoase, David, & Koster, 2014). However, insufficient research has investigated whether negative-avoidance ABM which trains people to avoid negative stimuli is effective in improving positive affect, which has implications for delivering ABM to increase life satisfaction in both clinical and nonclinical populations.

Research has shown that negative and positive attentional biases might be related to positive affect. According to the model of emotional regulation (McRae & Gross, 2020), the emotional regulation procedure includes four stages: situation selection (e.g., avoiding or approaching stressful situations), attention deployment, cognitive change, and response modulation. Therefore, higher attention to negative information in an environment may induce negative thoughts and reduce positive affective responses to the situation. Whereas, higher attention to positive information may increase positive thoughts, and increase positive affective responses to the situation. Empirical studies have lent support to the relationship between negative and positive attentional bias and positive affectivity. A study evaluated if biased attentional processing of positive information over neutral information is a characteristic of people with high positive affectivity (Grafton & MacLeod, 2017). The study administered the dot-probe task to adult participants to assess attentional bias and found that participants with higher positive affect showed increased positive attentional bias. Thus, the significant relationship between positive affect and attention to positive information was supported. Another research investigated the mediating role of negative and positive attentional biases in the relationship between positive affect and depression symptoms in adults (Xu et al., 2015). The study revealed that adult participants who had higher positive affect had higher self-report positive attentional bias and lower self-report negative attentional bias. Positive affect prevented depression symptoms via increasing self-report positive attentional bias and reducing self-

report negative attentional bias (Xu et al., 2015).

Attentional Bias Modification and Subjective Happiness

Because of the relationship of negative or positive attentional biases to positive affect, attentional bias modification which targets positive attentional bias might contribute to higher positive affect. Happiness is one of the most investigated positive effects. Subjective happiness is defined as ”a global, subjective assessment of whether one is a happy or an unhappy person” (Lyubomirsky & Lepper, 1999). It is associated with higher life satisfaction better relationships, and subjective well-being (Akin & Akin, 2014; Diener & Suh, 2000). Subjective happiness consists of three components: satisfaction with life, positive affect, and negative affect. Previous research has shown that attentional bias modification can enhance attention to happiness and reduce feelings of depression (Dai, Hu, & Feng, 2019). The study revealed that attentional bias modification increased attention towards happiness-related information which predicted reduced depression after one month. However, this study did not directly examine the effect of attentional bias modification on subjective happiness. Research revealed that when adding attentional bias modification that increases positive attentional bias to the intervention of writing a gratitude letter, the combined intervention maintained a positive affect throughout the study, which was not found in the intervention of gratitude letter without attentional bias modification (Stone, Lindt, Rabinovich Norka, & Gilbert, 2022). Thus, the addition of training that increases attention towards positive stimuli might help increase the effect of an intervention on positive affect. In conclusion, these studies showed that attentional bias modification might have a significant effect on happiness. However, most of the research on ABM only focused on negative avoidance ABM and investigated its effect on negative affect such as anxiety and depression. No studies have investigated the effect of Negative avoidance ABM on subjective happiness. Also, it is unknown whether adding ABM positive-search that targets positive attentional bias to negative avoidance ABM would increase the effect on happiness. Findings would contribute to the understanding of how ABM can be delivered to increase subjective happiness. Also,

by comparing the effect of negative avoidance ABM with the effect of the combination of Negative avoidance ABM and ABM-positive-search, the results would shed light on whether adding positive search ABM would increase the effect of ABM training on happiness.

Gamification of Mobile Attentional Bias Modification

A novel development of attentional bias modification is to gamify the intervention, which has gained increasing attention (Buday, Baranowski, & Thompson, 2012). By delivering the intervention via mobile games, the treatment can be more accessible and much cheaper (Kazdin & Rabbitt, 2013). By integrating different game formats and game techniques (e.g., rules, and avatars) with attentional bias modification, the intervention becomes more attractive to children and adolescents who are easier to be bored and distracted during the traditional treatment session. Thus, gamification of attentional bias modification might imply reducing the drop-out rate and increasing the motivation to seek treatment, especially in children and adolescents (Pieters et al., 2017).

Previous studies testified to the effectiveness of gamified attentional bias modification mobile apps in reducing emotional symptoms in children and adolescents. The ReThink game was developed based on the ABM-positive-search, which is a gamified ABM designed to train attention toward positive faces(David & Magurean, 2022). A study tested the effect of the ReThink game on attentional biases and mental health in children and adolescents between 10-16 years (David & Magurean, 2022). The study showed that the game significantly increased children's attention to positive stimuli (David & Magurean, 2022). This suggested that gamification of ABM is a promising method to change attentional biases in children. Moreover, evidence has lent support that gamification of ABM might produce better psychological outcomes than the traditional ABM. A study compared the effect of the traditional dot-probe ABM and a novel gamified ABM named "Emotion-in-Motion" in changing anxiety vulnerability. Results showed that only Emotion-in-Motion was effective in modifying attentional bias and anxiety vulnerability. This study showed that gamified ABM might be superior to traditional ABM. Therefore, it is warranted to develop novel

gamified ABM procedures and investigate the effect of gamified ABM in future studies, which has important implications for delivering more attractive and accessible interventions for children.

The Present Preliminary Study

As mentioned above, the majority of research only focused on negative avoidance ABM or the dot-probe paradigm in reducing negative affect, and no study investigated its effect on happiness. Moreover, it is unclear if adding positive search ABM which targets positive attentional bias to negative avoidance ABM would increase its effect on happiness. The present study developed a novel procedure for gamifying positive-search ABM and negative-avoidance ABM delivered on mobile phones.

Additionally, previous studies have shown that a single session of ABM is effective in reducing anxiety (Dennis & O'Toole, 2014). Multiple existing mobile applications for gamified ABM (e.g., “Bias Modification”) have been launched to the market. The application instructs the users to engage in ABM training for only 15 minutes in one session. The majority of research tested the effect of multiple sessions of ABM lasting for above 15 minutes (Amir et al., 2009; Beard et al., 2012; Lazarov et al., 2018; Linetzky et al., 2015; L.-y. Liu et al., 2015; Teng et al., 2019). However, insufficient research has investigated the effect of a single brief session of ABM training, which has implications for promoting gamified ABM to children who are busy studying at schools and have relatively shorter attention than adults. Thus, the present study tested the effect of a single brief session of gamified ABM on happiness.

It was hypothesized that 1) compared to the placebo training, the gamified Negative avoidance ABM group and the combined group would show significantly more increase in self-report positive attentional bias and subjective happiness. 2) Compared to negative avoidant attentional bias alone, adding positive search ABM would significantly increase self-report positive attentional bias and subjective happiness.

Methods

Participants

Adolescents from 15-19 years old were recruited from a secondary school located in Hong Kong. Inclusion criteria were proficiency in both written and spoken simplified Chinese, and no prior diagnosis of psychological disorders.

Invitations to participate in the study were sent through teachers in a secondary school in Hong Kong. 62 adolescents from the same secondary school in Hong Kong provided signed informed assent, and they also provided their parent's or guardians' informed consent. All participants were randomized into one of three groups: gamified negative-avoidance ABM, combined intervention, or placebo training. Descriptive statistics showed that the groups were comparable in terms of age, gender, and baseline scores on the happiness measure.

In total, 24 adolescents were assigned to the gamified negative avoidance ABM group, 18 to the combined intervention (negative avoidance ABM + positive search ABM), and 20 to the placebo training group. Refer to Figure 1 for the assignment procedure. The sample consisted of 55.8% males and 44.2% females with an average age of approximately 15.73 years (SD = 0.78).

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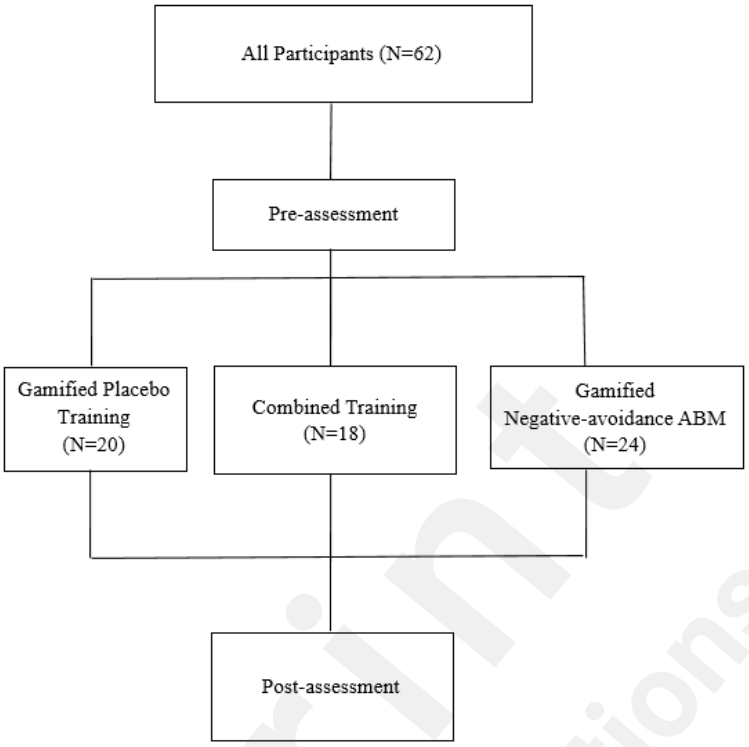

Figure 1. Procedure for random assignment of participants to the three intervention conditions *Note.*Combined Training=Gamfied Negative-avoidance ABM+Gamified Positive-search ABM; ABM=Attentional Bias Modification

Intervention Conditions

180 affective pictures were selected from an online resource of pictures. Three research assistants rated the affective value of selected pictures (60 negative pictures, 60 neutral pictures, and 60 positive pictures) using a Likert scale from 1 to 3. 1 indicated negative stimuli, 2 indicated neutral stimuli, and 3 indicated positive stimuli.

Gamified Negative-avoidance ABM

Based on the tenets of Attentional Bias Modification (ABM) principles detailed in prior research, the gamified negative avoidance ABM paradigm was conceptually rooted in Linke et al. (2019), who explored a gamified approach to Attention Bias Modification Training (ABMT) for anxious youth. In the adaptation, two pictures simultaneously appeared on the screen. One of them is a negative picture, and the other is a neutral or a positive picture. Participants were instructed to

control an airplane avatar on the screen to avoid negative pictures. Several blue dots appeared after these two pictures. To train participants to habitually avoid negative stimuli, the following rules were given: 1) If the airplane touches the negative picture, one life would be lost. 2) If the airplane lost three lives, the game is over. 3) If the airplane touches blue dots behind the negative pictures, participants' scores would decrease by one point. 4) If the airplane touches the blue dots behind the positive or neutral pictures, participants' scores would increase by one point.

As players progressed through levels, the speed of the airplane would increase so that participants needed to respond to the pictures more quickly, demanding sharpened attentional agility. Moreover, to add difficulty to the game as players progressed through levels, more and more red dots would appear among the blue dots. If the players touch the red dots, their scores will reduce, which increases the difficulty of the game. The core objective of this module aimed to strengthen participants' proficiency in consciously avoiding negative cues.

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Picture. 1. Demonstration of the gameplay in the gamified negative-avoidance ABM

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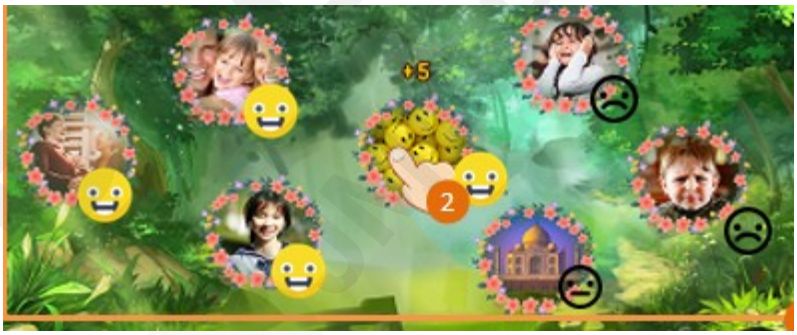
Gamified positive-search ABM

Building upon foundational principles of gamified attentional bias modification, this paradigm asked participants to discern and target images with positive emotions amidst a dominant backdrop of negative or neutral images. The pictures would appear on the screen for a short period. Before the offset of the pictures, participants were instructed to click all positive pictures among negative and neutral pictures. The framework for this task finds inspiration in a study by Nicolaidou et al. (2021), which expounded the benefits of a gamified application targeting emotion recognition and anger management among preschoolers. To train participants to habitually search for positive stimuli, the following rules were given.1) If participants click on a positive picture, their scores will increase by five points. 2) If participants mistakenly click on a negative picture, one life would be deducted. 3) If participants click on a neutral picture, their scores will not change. As the difficulty level progressed, the negative-to-positive image ratio increased, heightening the difficulty. Also, the period between the onset and the offset of the pictures became shorter.



Picture. 2. Demonstration of the gameplay in the gamified positive-search ABM

Gamified Placebo Training

The placebo training offered a structured exercise for participants. In the training, participants were prompted by a cartoon character to write down positive experiences in the past week on the app. Upon submission of the writing to the system, participants received a piece of virtual cake as a reward, which was then used to feed a cartoon character.

Measurement

Attention to Positive Information

Attention to positive information was measured by the Attention to Positive Information subscale from the brief version of the Attention to Positive and Negative Information Scale (Zhang, 2023). The 4-item scale measures attentional biases toward positive stimuli. Participants rated the items on a five-point Likert scale (e.g., I pay attention to positive characteristics of myself). The tool has been instrumental in understanding individuals' attentional preferences for positive information. The scale has shown good internal consistency in the current study (Cronback's alpha pre-intervention = 0.809, post-intervention = 0.895). API scores were calculated by summing scores from each item in the API subscale. The higher the score, the stronger the attentional biases.

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Subjective Happiness

The Subjective Happiness Scale-Chinese version (SHS-C, Lyubomirsky & Lepper, 1999) was utilized. This standardized tool consists of four items evaluating overall subjective happiness. For instance, participants responded to prompts including, “In general, I consider myself…” on a 7-point Likert scale, ranging from 1 (not a very happy person) to 7 (a very happy person). Notably, the fourth item is negatively worded and was reverse-coded for subsequent analysis. The Subjective Happiness Scale (SHS) has shown good internal consistency in the study with a Cronbach’s alpha of 0.709 (pre-intervention) and 0.872 (post-intervention), indicating a satisfactory level of reliability that improved post-intervention. Happiness scores were calculated by averaging scores for each item.

Demographic questionnaires

Adolescents reported their age, birthplace, and gender as a response to the three questions asking for their age, gender, and birthplace.

Procedure

The study received endorsement from the institutional ethical review board of the Social and Behavioral Science Department of the City University of Hong Kong. Informed consent was acquired from the parents or guardians of all participating children, and assent was taken from the children themselves. The participants were ensured that their participation was voluntary and that they could withdraw from the study at any point without any consequence. All personal data and responses were kept confidential and were used only for this study.

Upon obtaining the required consent, eligible individuals from three classes of a secondary school in Hong Kong were subjected to random group allocation via computer generation, ensuring unbiased distribution. The three training groups derived from this randomization encompassed: 1) singular gamified negative-avoidance ABM, 2) the combined intervention (gamified negative-avoidance

followed by positive-search ABM), and 3) the placebo training.

Interventions were administered on a mobile application in a classroom environment. The combined intervention was initiated with the gamified negative avoidance ABM training followed by the gamified positive search ABM training.

Before the training, students were given iPads to scan a QR code for the assessment of positive attentional bias and subjective happiness, which lasted for approximately 10 minutes. After that, each student was assigned a mobile phone, preloaded with the relevant gamified modules tailored to their assigned intervention group. The training session lasted for roughly 20 minutes. Following this, another QR code was provided to participants for post-assessment of self-report positive attentional bias and subjective happiness, which took another 10 minutes. The research team diligently monitored this entire procedure, ensuring participants' alignment with the intervention's protocol and their overall safety.

Data Processing and Analysis

The data for this study was processed using R software (version 4.3.1). Before the primary analysis, all entries with missing values were identified and systematically removed to maintain data consistency. Data from 16 participants were deleted due to missing values.

After data cleaning, preliminary analyses including chi-square tests and one-way ANOVAs were conducted to assess whether demographic statistics and the baseline scores on the outcome variables differed in terms of the intervention conditions. To assess the effect of intervention groups on the attention to positive information and subjective happiness as the outcome variables, repeated-measure ANOVAs were performed. A model with three levels of intervention groups as the between-subject variable, two levels of assessment time (pre-assessment and post-assessment) as the within-subject variable, as well as the within-between interaction terms, were performed. The interaction terms included the interaction of the intervention groups and assessment time. A power analysis indicated that to detect a Time × Condition interaction between the three

groups in predicting happiness scores, with a medium effect size (Cohen's d = 0.25), a power of 80%, and an alpha of .05, a minimum of 42 participants were required. Thus, the sample size of the present study is suitable for conducting the repeated-measure ANOVAs.

Results

Descriptive Statistics

Demographic differences in age (F = .113, p = .738), sex ratio (χ^2 = 4.505, p = .105), and birth place (χ^2 = 8.726, p = .068) among the three groups were insignificant. There were no significant group differences in baseline subjective happiness (F = 0.381, p = .540). These results showed that the three groups are well-matched in demographics and primary outcomes.

The Effect of Interventions on Attention to Positive Information

To evaluate whether the interventions induced alterations in participants' attentional bias, we conducted a repeated measures analysis of variance (ANOVA) using a two-factor design, with the factors of a group (negative avoidance, combined, positive control) and time (pre, post), to gauge attention to positive information. The results of the analysis indicated that there were no statistically significant main effects of group (F = 0.07, p = .797) or time (F = 1.65, p = .206). Furthermore, the interaction between time and group was also found to be non-significant (F = 0.25, p = .622). These outcomes suggest that no notable changes in attention to positive information were observed in any of the three gamified intervention groups.

The Effect of Interventions on Subjective Happiness

We performed a repeated measures ANOVA with a two-factor design, involving the factors of group (negative avoidance, combined, positive control) and time (pre, post), to assess subjective happiness. The analysis revealed no significant main effect of group (F = 0.02, p = .881), and no significant main effect of time (F = 2.20, p = .145). Additionally, the interaction between time and group was also non-significant (F = 2.23, p = .142). These findings indicate that there were no significant changes in subjective happiness within any of the three gamified intervention groups.

Refer to Table 1 for the statistics.

Table 1.

Outcome variables by the three groups

	Negative avoidance	Combined intervention	Positive control	$F/\chi 2$	*p*
Subjective happiness (M ± SD)					
Pre-training	4.49±0.99	4.71±1.23	4.23±1.22	0.603	.552
Post-training	4.31±1.24	4.21±1.32	4.67±1.61	0.457	.636
Attention positive information (M ± SD)					
Pre-training	14.06±2.60	13.75±3.36	13.56±2.42	0.138	.871
Post-training	12.61±3.33	13.50±3.63	12.63±2.87	0.325	.724

Notes. M=Mean; SD=Standard Deviation

Discussion

The Effect of Attentional Bias Modification on Attention to Positive Information

Contradictory to the hypothesis, neither negative-avoidance ABM nor the combined intervention has a significant effect on attention to positive information. This finding contradicted previous results which showed that attentional bias modification enhanced attention to happiness (Dai et al., 2019). It should be noted that participants in the previous study completed ABM every day for 10 days (Dai et al., 2019). Whereas, participants in the present study only conducted ABM once for 15 minutes. The disparity in the training duration and frequency might explain the inconsistency in the findings. Moreover, the present study assessed attention to positive information by self-report inventory, and the previous study measured the positive attentional bias by behavioral task. A self-report measure of positive attentional bias might represent a personal tendency to selectively attend to positive information in daily life which might be a stable personality (Noguchi,

Gohm, & Dalsky, 2006). Thus, changes in self-report positive attentional bias might be difficult without receiving long-lasting and intense attentional bias training. Moreover, the results might suggest that the gamification methods in the present study might not be ideal in inducing immediate changes in self-report attention to positive information, especially after only one brief session of ABM training.

Previous studies suggested that positive-search ABM was a promising ABM that might be better at increasing positive attentional bias than negative-avoidance ABM (K. Mogg et al., 2017; Waters et al., 2015). However, the present study demonstrated that adding positive-search ABM to negative-avoidant ABM did not increase the effect of negative-avoidance ABM on self-report positive attentional bias. One of the possible explanations might be that the training duration was too short and the frequency was too low so that neither the combination of the interventions nor negative-avoidance ABM took effect. Another explanation might be that the rationale underlying positive-search ABM and negative-avoidance ABM is similar, as the two approaches might target the same mechanisms for changes which includes both negative and positive attentional biases.

Despite the insignificant effect on attention to positive information, the present study provided some implications for the effect of gamified ABM on positive attentional bias, which is usually ignored in research on the effect of ABM on attentional bias. Overall, the results showed that a single brief session of gamified ABM might not be enough to modify self-report positive attentional bias.

The Effect of Attentional Bias Modification on Subjective Happiness

Inconsistent with the hypothesis, the effect of negative-avoidance ABM and positive-search ABM on subjective happiness is insignificant. The results contrasted the findings from the previous study by Stone et al. (2022), which showed that adding positive-search ABM helps maintain a positive affect. Thus, although ABM was designed to modify negative and positive attentional biases, it had no significant effect on subjective happiness after a single brief training session. The short

duration and low frequency of the present gamified ABM training might explain the inconsistency in the results. Moreover, based on previous evidence supporting the effect of negative avoidance ABM on internalizing symptoms (e.g., Amir et al., 2009), ABM which was developed based on the cognitive theory of anxiety symptoms (Karin Mogg & Bradley, 2018) might have significant effect only on negative affect and have much less effect on subjective happiness. The insignificant effect of ABM on subjective happiness might also be explained by its insignificant effect on attention to positive information. Previous studies have revealed a significant association between positive attentional bias and positive affect (Xu et al., 2015). Therefore, ABM might affect subjective happiness only after it increases attention to positive information which might be the mechanism mediating the changes in happiness.

Moreover, the present findings also lend further evidence that adding positive-search ABM might not affect increasing happiness. This might be due to the insignificant effect of adding positive-search ABM on attention to positive information. Moreover, the method of gamification might also affect the effect of positive-search ABM and negative-avoidance ABM on happiness as previous studies showed that gamification might foster motivation (Pieters et al., 2017). Overall, the findings suggested that neither the combination of the two gamified ABM approaches nor the single negative-avoidance ABM affected subjective happiness after a single brief training session.

Implications

The results from the preliminary evaluation of the gamified ABM have implications for gamified ABM interventions. First, although some commercially available gamified ABM application suggests participants only used the application for 15 minutes in one session, the present study suggested that a single session of gamified ABM lasting for 15 minutes have an insignificant effect on subjective happiness. Thus, gamified ABM might require participants to engage in training for a longer time and multiple sessions for gamified ABM to effectively affect attention to positive information and subjective happiness. Secondly, the addition of positive-search ABM did not

increase the effect of negative-avoidance ABM in improving positive attentional bias and subjective. Thus, it is not necessary to develop two training paradigms to increase the efficacy of short-time ABM training. Moreover, previous research has shown the value of gamification in increasing the motivation to engage in training and the training effect (Pieters et al., 2017). However, the results suggested that the gamification of ABM as was present in the study might not be successful at increasing the effect on self-report positive attentional bias and subjective happiness for a single session of short-time training.

Limitations

The study is a preliminary evaluation of the gamified ABM. It cannot reveal the effect of gamified ABM delivered in multiple sessions with a longer duration in each session. Future studies are warranted to investigate if the effect of the gamified ABM is more significant when delivered for a longer period. Moreover, the preliminary study only used the self-report inventory to measure positive attentional bias, which is subjective to memory bias. Future studies need to assess positive attentional bias by more objective measures such as behavioral tasks and eye-tracking techniques. The preliminary study recruited only 62 adolescents from a secondary school in Hong Kong. The small sample size affected the power of statistical analyses and prevented us from conducting other relevant analyses that require a larger sample of participants to ensure sufficient power. Moreover, the results might only be applied to Chinese adolescents as the sample only includes Chinese adolescents. Because the study was conducted in Hong Kong, the majority of children live in Hong Kong, which might affect the generalizability of the findings to adolescents living in mainland China, given the significant difference in Chinese from Hong Kong and mainland China (Bhowmik, Cheung, & Hue, 2018). The gamification of ABM might not be the most effective and attractive. Future studies might need to increase the attractiveness and the effect of gamification.

Conclusion

The study presents a preliminary evaluation of a gamified ABM and compares the effect of

gamified negative avoidance ABM to the combination of gamified negative-avoidance ABM and positive-search ABM on self-report positive attentional bias and subjective happiness in a single brief 15-minute session. Results showed that the brief 15-minute session of gamified ABM was not enough to change adolescents' self-report positive attentional bias and subjective happiness. Adding positive-search ABM to negative-avoidance ABM did not increase the effect of the gamified ABM for adolescents.

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Data Availability Statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Disclosure statement

The authors declare that they have no conflict of interest.

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