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The Attention Training Technique Improves Children's Ability to Delay Gratification: A
Controlled Comparison with Progressive Relaxation

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Abstract

The ability to delay gratification at a young age is a predictor of psychological, cognitive, health, and academic later-life outcomes. This study aimed to extend earlier research and explore whether a metacognitive intervention, Wells' (1990) Attention Training Technique (ATT), could improve young children's ability to delay gratification compared to an active-control (Progressive Muscle Relaxation: PMR), and no-intervention group. One hundred and one children aged 5-6 years old were recruited from schools. Classes of children were randomly allocated to receive the ATT, PMR or no-intervention and tested at pre- and post-intervention on measures of delay of gratification (the Marshmallow Test) and verbal inhibition (Day/Night Task). Results showed that, even when covariates were controlled for, following ATT, children delayed gratification significantly longer than after PMR or no-intervention. ATT also improved verbal inhibition compared with the no-intervention group, whilst PMR did not. The results add to earlier findings; ATT appears to provide a simple and effective way of improving young children's ability to delay gratification which has previously been shown to predict positive outcomes in later-life.

Keywords: children, attention training technique, executive function, delay of gratification, metacognition

The Attention Training Technique Improves Children's Ability to Delay Gratification: A Controlled Comparison with Progressive Relaxation

The classroom can be a challenging place for children; they need to be able to pay attention to instructions, ignore distractions, switch attention between different tasks and control their emotional reactions to social demands. These skills require cognitive processes known as executive function, namely, the ability to retain and manipulate information, to shift attention between competing demands and resist impulses. Executive function has been implicated in psychological vulnerability in adults (Hammar & Ardal, 2009; Wells & Matthews, 1994, 1996), with emerging evidence suggesting that impairments in this area in children provide a marker for psychological vulnerability (Hulvershorn, Cullen, & Anand, 2011; Vilgis, Silk, & Vance, 2015).

An important component of executive functioning is self-control; being able to resist or inhibit thoughts, feelings and behaviours to achieve longer-term goals. The seminal delay of gratification paradigm, the Marshmallow Test (Mischel & Ebbesen, 1970) has consistently been used to examine children's ability to employ self-control in laboratory and school settings (Duckworth, Tsukayama, & Kirby, 2013). In this test children are given one treat and told that if they can wait until the researcher returns, they will get two. This form of self-control requires children to inhibit the urge for an immediate reward to receive a more desirable reward later. Studies have shown that only around a third of young children are able to delay gratification and resist the treat in the Marshmallow Test (Mischel & Ebbesen, 1970). Children's greater ability to delay gratification has been associated with better later-life psychological, cognitive, academic, and health outcomes (Ayduk et al., 2000; Mischel, Shoda, & Peake, 1988; Shoda, Mischel, & Peake, 1990). This raises the question of whether it is possible to intervene at an early age to train executive functioning skills, specifically to improve young children's ability to delay gratification, with the suggestion that this will improve psychological, cognitive, academic, and health outcomes later.

A wealth of research has indicated that attention is a crucial mechanism that underpins children's ability to delay gratification (Eigsti et al., 2006; Rodriguez, Mischel, & Shoda, 1989). When children are presented with a treat, it is thought that emotion areas of the brain, the limbic system (the "hot" system) activates, which produces the urge to seek out pleasure. Those children who can implement strategies to employ their "cool" system (i.e. areas of their pre-frontal cortex) are more successful at delay (Metcalf & Mischel, 1999). This involves different components of executive functioning such as a child directing their

attention away from the reward or altering the cognitive representation of the reward, such as thinking of the marshmallow as a fluffy cloud instead of a desirable treat (Mischel et al., 1989).

Previous attempts to improve components of executive functioning through the delivery of various attention training procedures in schools have shown positive effects. Streb, Hille, Schoch, and Susic-Vasic (2012) delivered 30 minutes of computerised attention training to 4-6 year old children for five days. Results indicated improvements in cognitive flexibility and inhibition. Rueda, Checa, and C3mbita (2012) delivered similar computerised attention training to 5 year old children and found faster activation of brain regions associated with executive function, which were maintained two months post-intervention. Karbach and Kray (2009) found that attention training resulted in transfer effects to other domains of executive function. Specifically, children who received attention training displayed improvements in their ability on other executive function tasks and fluid intelligence. Taken together, these findings indicate the feasibility of delivering attention training to young children within a school setting to improve components of executive functioning. However, studies that have examined the effect of attention training to date have not considered the effect on children's ability to delay gratification. Delay of gratification is especially relevant as a component of executive functioning because the evidence suggests that it predicts long-term psychological, cognitive and health outcomes (Ayduk et al., 2000; Mischel, et al., 1988; Shoda et al, 1990). There are other considerations too. The attention training that was used in previous childhood studies tended to be lengthy (up to 7.5 hours over five weeks: Rueda et al., 2012). This is likely to be challenging to implement within a classroom setting, as teachers consider the relevance and timescales of interventions to be important to their utility (Richardson et al., 2015). Furthermore, previous attention training strategies were not based on an explicit theory of mechanisms linking self-control (i.e. delay of gratification), attention and psychological health outcomes.

It is possible that attention techniques based on such a theory may be especially effective. A candidate strategy for enhancing executive functioning required to delay gratification and improving later mental health outcomes is Wells' Attention Training Technique (ATT: Wells, 1990). The ATT is a theory-based intervention grounded in the Self-Regulatory Executive Function (S-REF: Wells & Matthews, 1994, 1996) model. In this model, difficulties in self-control and psychological vulnerability share a common underlying process of over-thinking and attention fixation on emotion related stimuli. In the context of the Marshmallow Test, those children who are more successful at delay would be considered

to have greater ability to shift from extended reward-related processing (i.e. they can move their attention away from thinking about the desirable and pleasurable aspects of eating the treat) and thereby resist the reward. This is likely to be indicative of a wider ability to shift attention from other patterns of affect-related extended thinking (e.g. anxious or depressive ruminations) that contribute to psychological vulnerability. Therefore, it can be hypothesised that if ATT can improve attentional flexibility in children, then they would be able to shift their attention away from emotion-related processing (i.e. focusing on a treat and thoughts of instant gratification of consuming the reward) towards goal-directed processing (i.e. focusing on the longer-term, larger reward). In fact a crucial mechanism that underpins delay of gratification is how children allocate attention as they wait (Rodriguez et al., 1989). Thus, a specific mechanism; attentional flexibility (control) could link early delay ability to later psychological health outcomes.

The ATT involves listening to approximately 11 minutes of sounds (e.g. running water, traffic, bells) and following a narrator's instruction to focus selectively, move attention between the sounds and then divide attention. This process is designed to reduce self-focused attention on thoughts and feelings and strengthen an individual's self-regulatory abilities i.e. their ability to be more flexible. For example, by disengaging attention from unwanted stimuli and actively prioritising processing of other stimuli under competing attentional demands.

The ATT has been shown to improve attention flexibility in the adult population in as little as 2 - 6 sessions (Callinan, Johnson, & Wells, 2015; Nassif & Wells, 2014), reduce amygdala responsivity to emotional stimuli (Siegle, Ghinassi, & Thase, 2007) and lead to significant improvements in symptoms of psychological disorder (Fergus & Bardeen, 2016; Knowles, Foden, El-Deredy, & Wells, 2016).

In a previous study (Murray, Theakston, & Wells, 2016), the ATT significantly improved children's ability to delay gratification. Children who received three sessions of the ATT were 2.64 times more likely to delay gratification post-intervention compared to those who received no-intervention. However, such effects would be further supported if the ATT was found to have an effect beyond that of other active control conditions. It would also be more convincing if it enhanced additional parameters of executive control. One such dimension is verbal inhibition measured as the ability to inhibit an overlearned response. Verbal inhibition was measured in the Murray et al. (2016) study using the Day/Night task (Gerstadt, Hong, & Diamond, 1994). The task requires children to inhibit the impulse of providing an automatic verbal response and employ a rule they have been given. The study

found that on this dimension the effects were not-statistically significant, but the study may have lacked power to detect such an effect. Because, the verbal inhibition task has potential to evaluate whether the effect of the ATT on delay of gratification is generalizable to wider executive functioning measures it should be examined further.

In combination, the results of earlier research in both child and adult populations suggest that the ATT could not only be beneficial at improving psychological symptoms in adults but might improve children's ability to delay gratification. The one previous study with children (Murray et al., 2016), which showed improvements in delay of gratification associated with ATT, did not use an active control group. It is not possible therefore to establish whether the effect of the ATT was due to the specific ATT technique or simply due to the non-specific factors in provision of an intervention. To examine this question, the aim of the present study was to further test the effect by comparing ATT with Progressive Muscle Relaxation (PMR) and no-intervention and to examine any wider effects on verbal inhibition.

The PMR was selected as a control intervention because it could be matched in length and narrator's voice to the ATT and represents an intervention that has been delivered in schools (Viegas, 2013). The PMR consists of instructions to tense and release different parts of the body (e.g. fists and legs). The aim of including the PMR as an active-control condition was not to run a definitive comparative trial against a well specified alternative intervention, but to use a credible comparator that offered control over non-specific factors such as the placebo effect and a change in the school regime. The PMR was not predicted to improve delay of gratification or verbal inhibition. Given that the ATT aims to strengthen self-regulatory abilities specifically, it was predicted that children who received the ATT would be more successful at delaying gratification than those who received PMR or no intervention. Furthermore, as an adjunct we tested whether there would be additional differences in verbal inhibition favouring the ATT condition.

Aims of Present Study

The aim of this study was to build on a preliminary study and examine whether the ATT, when delivered in schools, would improve delay of gratification. Based on previous studies the following hypothesis was tested:

- Children in the ATT condition will show an improved ability to delay gratification post-intervention compared to those in the PMR and the no-intervention condition.

To further understand the effectiveness of the ATT, two additional questions were explored:

- What effect does the ATT have on delay of gratification when confounding factors are controlled for?
- Does the ATT (or PMR, or no-intervention) have any impact on wider indices of executive control, i.e. children's verbal inhibition?

Method

Participants

Participants were recruited from nine schools (13 classes) in Staffordshire, England. The final sample consisted of 101 children ($M = 6.24$ years old; $SD = 0.33$ years; range = 5.55 – 6.82 years; 61 female). Inclusion criteria were: ability to speak fluent English and absence of a learning or behavioural difficulty (e.g. ADHD or ASD; parent-reported). One hundred and four consent forms were initially returned. One child was absent at T1 testing and therefore not included. A further two children were withdrawn at the intervention stage as they were absent for one or more intervention sessions.

Design

This study aimed to replicate and extend an earlier study exploring the effectiveness of the ATT (Murray et al., 2016), therefore the design of the initial study was upheld and extended with the addition of a third condition (PMR). The preliminary study recorded whether children could, or could not delay gratification for 780 seconds (yes/no). The present study measured the number of seconds children could delay gratification (between 0 and 780 seconds) to allow for more robust statistical analysis. The preliminary study measured the Day/Night task (Gerstadt et al., 1994) to principally examine and control baseline differences in verbal inhibition and this was retained and used in a similar way in the present study and we also examined the effects of ATT on this task.

A mixed-model design was used where whole classes of children were randomly allocated to either the ATT condition ($n = 30$ children; two classes), PMR condition ($n = 33$; five classes), or no-intervention ($n = 38$; six classes). All children were tested at baseline (T1) and seven days post-baseline (T2). During the seven days between T1 and T2, the class teacher delivered the allocated intervention (or no-intervention) on three occasions. The intervention was delivered to the whole class although only those children who had received parental consent participated in the study measures.

The primary outcome was the number of seconds children were able to delay gratification at T2. The control variables in the primary analysis were: number of seconds

children were able to delay gratification (Marshmallow Task: Mischel & Ebbesen, 1970) at T1; children's score on a verbal inhibition task (Day/Night: Gerstadt et al., 1994) at T1. To account for potential confounding factors, the following variables were also measured: number of months attended school; age; academic performance; and attention level in class over the week prior to the intervention.

Procedure

The study was approved by Staffordshire University's Ethics Committee. All primary schools in Staffordshire were contacted about the study. Twelve schools responded and expressed an interest in participating. Three schools were unable to participate due to other commitments during the academic year. Nine schools agreed to participate. The researcher provided parent information sheets and consent forms which were distributed by the schools to all Year 1 children meeting the inclusion criteria. Only children whose parents completed and returned a parental consent form were eligible to participate in the study. Prior to the testing phase, each class was randomly allocated using simple block randomisation (using a randomiser tool: www.randomizer.org) to one of the three conditions (ATT, PMR or no-intervention). The researcher was not blind to allocation of condition however, teachers were blind to the specific study hypothesis.

Intervention. ATT or PMR conditions were provided with an audio recording of the intervention and standardised instructions explaining how to it. Both interventions lasted approximately 11 minutes. The interventions were delivered by the class teacher to the whole class on three separate occasions, at the teachers' convenience during the seven days between T1 and T2. Teachers were asked not to deliver any other relaxation, attention, or mindfulness-related activities during the study period. Intervention fidelity was established through verbal reports from the teacher at the end of the intervention phase.

ATT. The ATT (Wells, 1990) is an auditory intervention which aims to enhance attentional flexibility. The ATT consists of a range of sounds (e.g. bells, traffic and running water) presented simultaneously in which some are continuous and others are intermittent and at different spatial locations. A narrator instructs children on where to focus their attention, for example, to focus on one specific sound and then to move their attention to another sound and location in succession.

PMR. The PMR intervention was chosen due to its substantial use with young children in schools (Viegas, 2013). PMR acted as an active control condition where children had to listen and follow instructions for 11 minutes. Unlike the ATT, the PMR did not require

children to repeatedly shift their attention. The PMR recording instructs children to tense and release muscles in their body with the aim of creating relaxation.

No-intervention. Children in the no-intervention condition continued with normal school activities.

Measures

All children were tested at T1 and T2 by the same female researcher who had no prior connection to the school. Children were tested individually in a room in their school, with sessions lasting 15-25 minutes. On the first day of testing, a worksheet was used to explain the study to the children and capture their assent.

Delay of gratification paradigm. A replication of the Marshmallow Test (Mischel & Ebbesen, 1970) was chosen due to its established validity and acceptability with this population (Duckworth et al., 2013). The test was administered at T1 and T2. To ensure desirability, each child was given a choice of treat (one chocolate button, one jelly baby or a grape). The treat was placed on the table in front of them. They were told: “You can eat this treat now, or if you wait until I come back you will get two”. The researcher checked the child’s understanding and then left the room. A stopwatch was used to time how long the child was able to delay, which was recorded in seconds, up to a maximum of 780 seconds. Children were positioned with their back to the door, ensuring the researcher could see the child through the window in the door to know when they had eaten the sweet. If the child waited 780 seconds, they received two treats. If the child ate the sweet before the 780 seconds elapsed, or left the room, they received one treat.

Verbal inhibition task. To assess individual differences in children’s executive function, the Day/Night task (Gerstadt et al., 1994) was used ($KR-20 = .89$). Children were presented with sun or moon cards and instructed to say “day” when the moon card was presented and “night” when the sun card was presented. To ensure children’s understanding of the instructions, two practise trials were delivered. It was anticipated that if children failed both practise trials, they would be withdrawn from the study as this would suggest they did not understand the rule. However, no child in this study failed both practice trials. Following the practice trials, children were presented with 16 presentations of either a sun or moon card, at one second intervals in line with Gerstadt et al.’s (1994) protocol. The number of correct responses was recorded. The measure was taken at T1 and T2.

Teacher ratings. The class teacher was asked to provide three measures: (a) a rating of the child's attention in class during the week prior to intervention (or no-intervention) and the week following the intervention. This was provided on a scale of 1-10 (1 = significantly poor attention; 10 = exceptional attention); (b) the number of months the child had been in school; and (c) each child's academic rating, in line with the national curriculum, measured as: average for their age, below average, or above average. Teachers were also asked to indicate whether their class had engaged in any mindfulness, relaxation or similar activities. No classes had engaged in such activities during the current academic year.

Power calculation. A power calculation (Cohen, 1992) was undertaken to determine the required sample size for the between-subjects effect for the ANOVA. With power set at 0.80 for a large effect size (0.50), based on previous research (Murray et al., 2016), and significance set at 0.05, 21 participants were required per group (total $n = 63$). However, given the preliminary nature of the Murray et al. (2016) study we aimed to recruit a larger sample. The required sample was exceeded in the current study ($n = 101$). This sample is larger than samples used in previous studies examining the effect of other attention training procedures in this population (Karchach & Kray, 2009; Rueda et al., 2005, 2012; Streb et al., 2012).

Results

Baseline Measures

Descriptive statistics are reported in Table 1. There were no statistically significant differences in children's age or length of time in school between conditions.

At baseline (i.e. T1), there was no significant difference between experimental conditions in children's score on the Day/Night task, $F(2, 98) = 0.47, p = .67$, seconds children were able to delay gratification, $F(2, 98) = 0.25, p = .78$, or attention ratings, $F(2, 98) = 1.35, p = .26$.

Children were nested in classes in schools in this study, with the risk that the class and school impacted on the primary dependent variable (delay of gratification) at baseline (T1) and post-test (T2). This would require hierarchical linear modelling to control for nested factors when they are related to outcome. However, univariate testing showed that neither class [$F(12, 101) = .94, p = .51$] or school [$F(8, 101) = 1.28, p = .26$] was associated with delay of gratification score at baseline (T1) or at post-intervention (T2) [class: $F(12, 101) = 1.20, p = .29$], [school: $F(8, 101) = 1.51, p = .17$].

Effect of Intervention: Primary Outcome (Delay Gratification)

To examine whether the change in children's ability to delay gratification between T1 and T2 differed between conditions, a mixed-model ANOVA was computed. A 2 (Time: Pre vs Post) x 3 (Condition: ATT vs PMR vs no-intervention) ANOVA revealed a significant effect of time, $F(1, 98) = 32.79, p < .0005, \eta p^2 = .25$ and no significant effect of condition, $F(2, 98) = 1.23, p = .30, \eta p^2 = .02$. There was a significant interaction between time and condition, $F(2, 98) = 5.34, p = .01, \eta p^2 = .10$. To locate differences in the within-subject change across groups, change scores were computed (number of seconds able to delay at T2 minus number of seconds able to delay at T1). Mean change scores by condition are displayed in Figure 1. A one-way ANOVA was undertaken to examine differences in change scores between the conditions. Bonferroni post-hoc tests showed that the improvement in ability to delay gratification between T1 and T2 was significantly greater for children in the ATT condition ($M_{Change} = 199.30; SD = 219.62$) than children in the no-intervention condition ($M_{Change} = 60.53; SD = 185.36$), $p = .01$. Children in the ATT condition also improved significantly more than children in the PMR condition ($M_{Change} = 67.61; SD = 166.99$), $p = .02$. Children in the PMR condition did not improve significantly more between T1 and T2 than children in the no-intervention condition, $p = .99$.

Factors Affecting Delay of Gratification

To explore which variables correlated with ability to delay gratification at T2, bivariate correlations were examined for all variables (Table 2). Day/Night score at T1 ($r(99) = .27, p = .01$), delay of gratification at T1 ($r(99) = .65, p < .0005$), Day/Night score at T2 ($r(99) = .46, p < .0005$) were significantly positively correlated with delay of gratification at T2, whilst months in school ($r(98) = -.20, p = .04$) was significantly negatively correlated with delay of gratification at T2.

An ANCOVA was run to examine whether the effect of the ATT remained when those variables which significantly correlated with ability to delay gratification at T2 (months in school, delay of gratification at T1 and Day/Night score at T1) were controlled for. Whilst Day/Night score at T2 was also significantly correlated with delay of gratification at T2, this variable was measured post-intervention as a secondary outcome, and it was not appropriate to partial out the effect of the interventions (or no-intervention) on this variable, therefore this variable was not included in the ANCOVA.

Delay of gratification at T1 was significantly related to children's ability to delay gratification at T2, $F(1, 95) = 69.28, p < .0005, \eta^2 = .42$. There was also a significant effect of condition, $F(2, 95) = 7.91, p = .001, \eta^2 = .14$. There was no significant effect of months in school, $F(1, 95) = 2.51, p = .12, \eta^2 = .03$ and no significant effect of Day/Night score at T1, $F(1, 95) = 0.00, p = .99, \eta^2 = .00$. Planned contrasts revealed that, when the covariates were controlled for, children in the ATT condition delayed significantly longer at T2 (adjusted $M = 772.64; SD = 35.61$) compared to children in the no-intervention condition (adjusted $M = 605.33; SD = 26.03$), $p = .001$, and compared to children in the PMR condition (adjusted $M = 576.66; SD = 31.49$), $p = .001$. Children in the PMR condition did not delay gratification significantly longer than children in the no-intervention condition, $p = 1.00$.

Verbal Inhibition: Secondary Outcome

Whilst the Day/Night task was used primarily to control for possible individual differences in executive functioning at T1 in the primary analysis (above), we also studied it as a secondary exploratory outcome to examine whether the intervention (or no-intervention) had an effect on children's performance on this parameter at T2.

A mixed-model ANOVA was run to explore whether the change in Day/Night scores between T1 and T2 differed between conditions. A 2(Time: Pre vs Post) x 3(Condition: ATT vs PMR vs no-intervention) revealed a significant effect of time, $F(1, 98) = 52.99, p < .0005, \eta^2 = .35$. There was a significant interaction between time and condition, $F(2, 98) = 5.02, p = .01, \eta^2 = .09$. To locate differences in the within-subject change across groups, change scores were computed (score at T2 minus score at T1). A one-way ANOVA was undertaken to examine differences in change scores between conditions. Bonferroni post-hoc tests revealed that Day/Night score improved significantly more between T1 and T2 for children in the ATT condition ($M_{Change} = 3.1; SD = 3.22$) compared to children in the no-intervention condition ($M_{Change} = 1.03; SD = 2.40$), $p = .01$. The change in Day/Night score between T1 and T2 did not differ between the ATT condition and the PMR condition ($M_{Change} = 1.76; SD = 2.49$), $p = .15$, or between the PMR and no-intervention condition, $p = .77$.

Discussion

This study aimed to replicate and extend an earlier study (Murray et al., 2016) to examine whether Wells' ATT delivered in schools would improve children's ability to delay gratification. It compared the effect to an active-control (PMR) or no-intervention condition whilst improving the sensitivity of the delay measure and examining wider effects. The study

also controlled for a number of parameters, namely children's performance on a verbal inhibition task (Day/Night task), days in school and baseline delay of gratification.

Results indicated that children who received three (11 minute) sessions of ATT showed an improvement in delay of gratification that was significantly greater than shown in the PMR or no-intervention condition. This effect remained when existing ability to delay gratification at T1, months in school and verbal inhibition (Day/Night score) at T1 were controlled for. There was no significant difference in improved ability to delay gratification between the PMR and no-intervention condition.

In line with previous findings these results indicate that the ATT intervention significantly improved children's ability to delay gratification with the extension that the effects appear specific to the ATT. The inclusion of a PMR intervention in this study was to control for the non-specific factors associated with introducing an intervention. The results observed suggest that the effect is not explained by non-specific factors there were part of each active condition (ATT and PMR) namely; placebo or demand factors, provision of an intervention, changes in behaviour associated with including a novel activity in the classroom, or changes in levels of attention from the teacher.

There was no significant difference in degree of improvement in the Day/Night task scores (verbal inhibition) for children in the ATT condition compared to children in the PMR condition. However, the ATT condition but not the PMR condition did show a significant improvement in verbal inhibition when compared with the control condition, suggesting possible wider effects of ATT on executive control, but this must remain more speculative and should be explored further.

An incidental finding was a negative association found between months in school and ability to delay gratification at T2 (but not at T1). It could be hypothesised that children who have been in school longer have a stronger sense of choice over their responses and were able to utilise their past knowledge of waiting for the reward at T1 (i.e. the relative value of the reward versus the length of time they had to wait) and chose to prioritise the immediate reward at T2 over waiting. However, further exploration of this hypothesis is required.

Clinical Implications

The findings provide additional evidence that the ATT might provide a brief intervention which could be used in the classroom to enhance children's self-control, at least as indexed by their ability to delay gratification. Subjective evaluations provided by teachers

indicated that the automated nature of the ATT allowed a straightforward fit with the existing curriculum.

Childhood ability to delay gratification has consistently been shown to be a predictor of psychological, academic, health and cognitive outcomes in later life (Mischel et al., 2011). Therefore, the results of this study give rise to an important hypothesis; ATT may not only improve children's ability to delay gratification, but could translate into enhanced later-life outcomes. The S-REF model (Wells & Matthews, 1996) suggests that ATT could act on a common set of underlying mechanisms that contributes to both delay of gratification and psychological vulnerability, one such mechanism is attention flexibility, but further exploration is required. Previous research has indicated that how children allocate their attention during the delay paradigm and their cognitive representation of the reward can be crucial mechanisms (Mischel et al., 1972; Mischel, 1974; Mischel & Ayduk, 2004; Rodriguez et al., 1989). Therefore future research should operationalise and measure such domains, for example, by measuring how long children look at the reward whilst they wait to further determine ATT effects.

Limitations

Given the design of the study, it is currently impossible to know whether the ATT has longer term effects and whether the improvements in ability to delay gratification can be generalised to other settings. Future studies should incorporate follow-up testing with other executive functioning or resilience measures (Isquith, Crawford, Espy, & Gioia, 2005). Whilst the nested factors of school and class did not appear related to the primary outcome in this study future studies should aim to minimise such design factors. We could not control for these in our analysis due to some small cell sizes at the individual class level (note; small cell sizes did not affect the primary analysis which used aggregated classes). However, the results replicate an earlier study that demonstrated effects of ATT on delay of gratification so the results are likely to be substantive rather than an artefact of factors linked to study design. Finally, the assessor of delay of gratification in this study was not blind to experimental condition which may have introduced experimenter effects and influenced the effects found in the study. Future studies should enable blind data collection and analysis.

In conclusion, the results are consistent with earlier research and indicated that three sessions of the ATT significantly improved children's ability to delay gratification. These effects were greater than those associated with a comparison (control) intervention suggesting the effects are specific to ATT rather than the result of non-specific factors associated with a

classroom intervention. Whilst studies of the efficacy of the ATT in children are in their early stages, these results show promising signs that the ATT could provide a brief and effective way of improving self-control in young children. However, further research is required to establish the optimal number of sessions required, to examine longer-term improvements in self-control, any effect on wider dimensions of executive functioning and the possible impact on later-life functioning.

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References

- Ayduk, O., Medoza-Dention, R., Mischel, W., Downey, G., Peake, P. K., & Rodriguez, M. (2000). Regulating the Interpersonal Self: Strategic Self-Regulation for Coping with Rejection Sensitivity. *Journal of Personality and Social Psychology*, 79, 776-792.
- Callinan, S., Johnson, D., & Wells, A. (2015). A randomised controlled study of the effects of the attention training technique on traumatic stress symptoms, emotional set shifting and flexibility. *Cognitive Therapy and Research*, 39, 4-13.
- Cohen, J. (1992). A Power Primer. *Psychological Bulletin*, 112, 155-159.
- Diamond, A., & Lee, K. (2011). Interventions shown to aid executive function development in children 4 to 12 years old. *Science*, 33, 959-964.
- Donaldson, T. S. (1968). Robustness of the *F*-test to errors of both kinds and the correlation between the numerator and denominator of the *F*-ratio. *Journal of the American Statistical Association*, 63, 660-676.
- Duckworth, A. L., Tsukayama, E., & Kirby, T. (2013). Is it really self-control? Examining the predictive power of the delay of gratification test. *Personality and Social Psychology Bulletin*, 39, 843-855.
- Eigsti, I. M., Zayas, V., Mischel, W., Shoda, W., Ayduk, O., Dadlani, M. B., Caasey, B. J. (2006). Predicting Cognitive Control from Preschool to Late Adolescence and Young Adulthood. *Psychological Science*, 17, 478-484.
- Faul, F., Erdfelder, E., Buchner, A., & Lang, A-G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods*, 41, 1149-1160.
- Fergus, T. A. & Bardeen, J. R. (2015). The Attention Training Technique: A Review of a Neurobehavioral Therapy for Emotional Disorders. *Cognitive and Behavioral Practice*. 23, 502-516.
- Gerstadt, C. L., Hong, Y. J., & Diamond, A. (1994). The Relationship between Cognition and Action: Performance of Children 3½ - 7 years old on a Stroop-Like Day-Night Test. *Cognition*, 53, 129-153.

- Hammar, A., & Ardal, G. (2009). Cognitive functioning in major depression – a summary. *Frontiers in Human Neuroscience*, 3, 26.
- Holder, M. D., & Coleman, B. (2008). The Contribution of Temperament, Popularity, and Physical Appearance to Children's Happiness. *Journal of Happiness Studies*, 9, 279-302.
- Hulvershorn, L. A., Cullen, K., & Anand, A. (2011). Towards dysfunctional connectivity: a review of neuroimaging findings in pediatric major depression disorder. *Brain Imaging and Behaviour*, 5, 307-328.
- Isquith, P. K., Crawford J. S., Espy, K. A., & Gioia, G. A. (2005). Assessment of executive function in preschool-aged children. *Mental Retardation and Developmental Disabilities Research Reviews*, 11, 209-215.
- Karbach, J., & Kray, J. (2009). How useful is executive control training? Age differences in near and far transfer of task-switching training. *Developmental Science*, 12, 978-990.
- Knowles, M. M., Foden, P., El-Deredy, W., & Wells, A. (2016). A Systematic Review of Efficacy of the Attention Training Technique in Clinical and Nonclinical Samples. *Journal of Clinical Psychology*, 72, 999-1025.
- Metcalfe, J. & Mischel, W. (1999). A hot/cool-system analysis of delay of gratification: dynamics of willpower. *Psychological Review*, 106, 3-19.
- Mischel, W. (1974). Processes in delay of gratification. In L. Berkowitz (Ed.) *Advances in Experimental Social Psychology*, vol. 7 (pp.249-292). New York: Academic Press.
- Mischel W., & Ebbesen, E. B. (1970). Attention in Delay of Gratification. *Journal of Personality and Social Psychology*, 16, 329-337.
- Mischel, W., Ebbesen, E. B., & Zeiss, A. R. (1972). Cognitive and Attentional Mechanisms in Delay of Gratification. *Journal of Personality and Social Psychology*, 21, 204-218.
- Mischel, W., Shoda, Y., & Peake, P. K. (1988). The Nature of Adolescent Competencies Predicted by Preschool Delay of Gratification. *Journal of Personality and Social Psychology*, 54, 687-696.
- Mischel, W., Shoda, Y., & Rodriguez, M. L. (1989). Delay of Gratification in Children. *Science*, 244, 933-938.

- Murray, J., Theakston, A., & Wells, A. (2016). Can the Attention Training Technique turn one marshmallow into two? Improving children's ability to delay gratification. *Behaviour, Research and Therapy*, 77, 34-39.
- Nassif, Y., & Wells, A. (2014). Attention training reduces intrusive thoughts cued by a narrative of stressful life events: a controlled study. *Journal of Clinical Psychology*, 70, 510-517.
- Richardson, M., Moore, D. A., Gwernan-Jones, R., Thompson-Coon, J., Ukoumunne, O., Rogers, M. . . . Ford, T. J. (2015). Non-pharmacological interventions for attention-deficit/hyperactivity disorder (ADHD) delivered in school settings: systematic reviews of quantitative and qualitative research. *Health Technology Assessment*, 19, 1-470.
- Rodriguez, M. L., Mischel, W., & Shoda Y. (1989). Cognitive person variables in the delay of gratification of older children at risk. *Journal of Personality and Social Psychology*, 57, 358-367.
- Rueda, M. R., Checa, P., & Cómbita, L. M. (2012). Enhanced efficiency of the executive attention network after training in preschool children: Immediate changes and effects after two months. *Developmental Cognitive Neuroscience*, 25, 192-204.
- Rueda, M. R., Rothbart, M. K., McCandliss, B. D., Saccomanno, L., & Posner, M. I. (2005). Training, maturation, and genetic influences on development of executive attention. *Proceedings of the National Academy of Sciences of the United States of America*, 102, 14931-14936.
- Shoda, Y., Mischel W., & Peake, P. K. (1990). Predicting Adolescent Cognitive and Self-Regulatory Competencies from Pre-School Delay of Gratification: Identifying Diagnostic Condition. *Developmental Psychology*, 26, 978-986.
- Siegle, G. J., Ghinassi, F., & Thase, M. E. (2007). Neurobehavioral therapies in the 21st century: Summary of an emerging field and an extended example of cognitive control training for depression. *Cognitive Therapy and Research*, 31, 235-262.
- Streb, J., Hille, K., Schoch, S., & Sosic-Vasic, Z. (2012). Attention Training Promotes Executive Functions of Kindergarten Children. *Neurology*, 6, 450-454.

- Viegas, M. (2013, September). *Introducing relaxation to the classroom: teacher's experiences*. Relax Kids. Retrieved from <http://www.relaxkids.com/UK/Tips-for/Education>
- Vilgis, V., Silk, T. J., & Vance, A. (2015). Executive function and attention in children and adolescents with depressive disorders: a systematic review. *European Child and Adolescent Psychiatry*, 24, 365-384.
- Wells, A. (1990). Panic Disorder in Association with Relaxation Induced Anxiety: An Attentional Training Approach to Treatment. *Behavior Therapy*, 21, 273-280.
- Wells, A. (2007). The attention training technique: Theory, effects and a metacognitive hypothesis on auditory hallucinations. *Cognitive and Behavioral Practise*, 14, 134-138.
- Wells, A., & Matthews, G. (1994). *Attention and emotion. A clinical perspective*. Hove: Erlbaum.
- Wells, A., & Matthews, G. (1996). Modelling cognition in emotional disorder: The S-REF model. *Behaviour, Research and Therapy*, 32, 867-870.

Table 1: Means and Standard Deviations for Dependent Variable and Independent Variables at T1 and T2 in each Condition

Condition	Measure	T1 (<i>SD</i>)	T2 (<i>SD</i>)
ATT Condition <i>n</i> = 30	Age (years)	6.07 (0.29)	
	Months in school	7.20 (1.86)	
	% Males	43.3	
	% Females	56.7	
	% Above average academically	36.7	
	% Average academically	43.3	
	% Below average academically	20.0	
	Seconds able to delay gratification	538.80 (254.37)	738.10 (131.39)
	Attention rating	6.63 (2.56)	7.20 (2.63)
	Day/Night score	10.20 (4.22)	13.30 (2.81)
PMR Condition <i>n</i> = 33	Age (years)	6.31 (0.34)	
	Months in school	10.64 (0.49)	
	% Males	36.4	
	% Females	63.6	
	% Above average academically	36.4	
	% Average academically	51.5	
	% Below average academically	12.1	
	Seconds able to delay gratification	520.12 (284.19)	587.73 (267.90)
	Attention rating	7.48 (2.15)	7.39 (2.12)
	Day/Night score	10.82 (4.29)	12.58 (3.97)
No- Intervention Condition <i>n</i> = 38	Age (years)	6.30 (0.30)	
	Months in school	9.50 (1.89)	
	% Males	39.5	
	% Females	60.5	
	% Above average academically	31.6	
	% Average academically	47.4	
	% Below average academically	21.1	
	Seconds able to delay gratification	562.37 (218.51)	622.89 (214.92)
	Attention rating	6.71 (2.29)	7.00 (2.17)
	Day/Night score	9.97 (3.34)	11.00 (3.96)

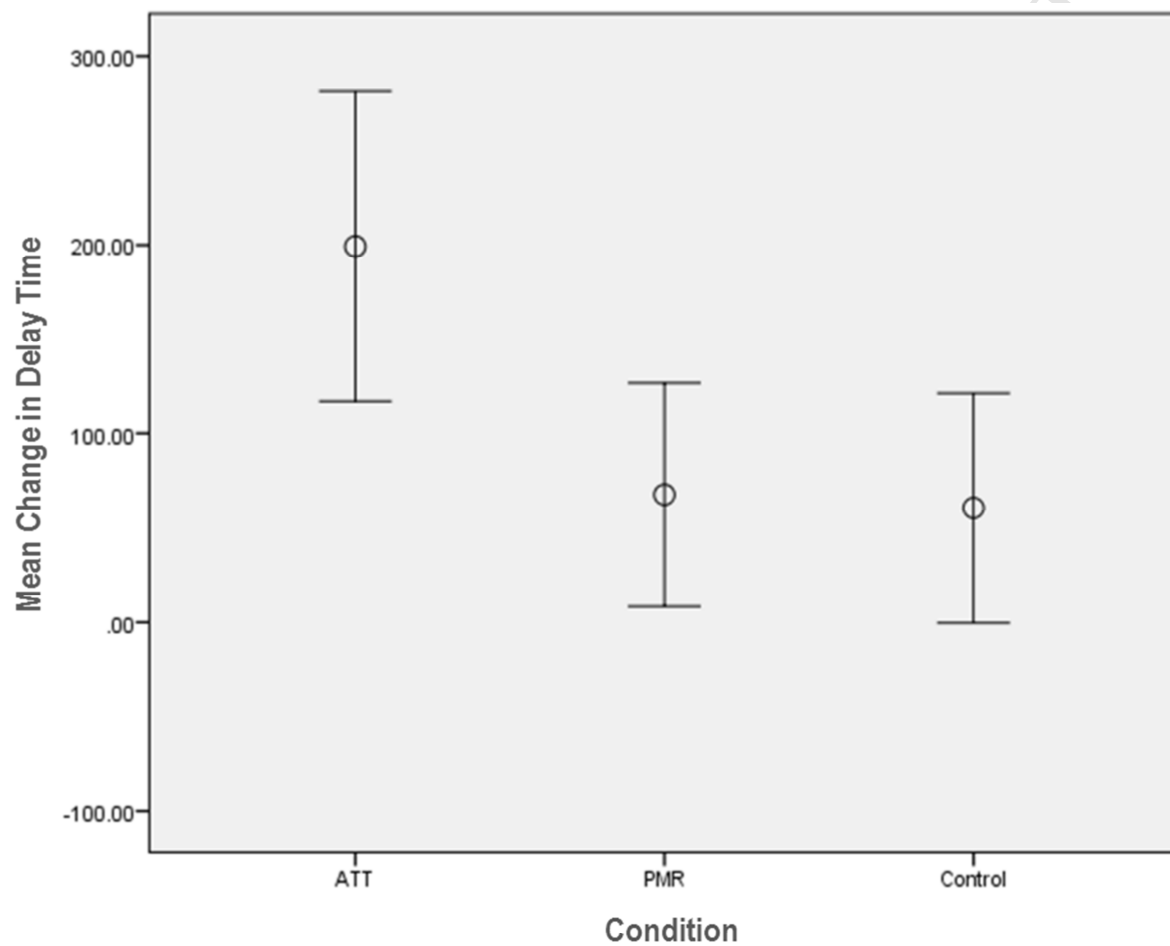
Table 2: Pearson Correlations of Dependent and Independent Variables

	Months in school	D/N at T1	DG at T1	ATr at T1	D/N at T2	DG at T2	ATr at T2
Age	.37**	.11	.04	.15	.06	-.09	.12
Months in school	-	-.06	-.17	.11	-.11	-.20*	.04
D/N at T1		-	.43**	.33**	.74**	.27**	.30**
DG at T1			-	.16	.40**	.65**	.21*
ATr at T1				-	.23*	.05	.95**
D/N at T2					-	.46**	.24*
DG at T2						-	.12

Note. Months in school = Months in school at T1 testing; D/N at T1 = Day/Night Task score at T1; DG at T1 = number of seconds child was able to delay gratification at T1; ATr at T1 = Attention Rating at T1; D/N at T2 = Day/Night Task score at T2; DG at T2 = number of seconds child was able to delay gratification at T2; ATr at T2 = Attention Rating at T2.

* $p < .05$; ** $p < .0005$

Figure 1. Change in ability to delay gratification (DG) between T1 and T2 in each condition (mean number of seconds with 95% confidence Intervals).



Highlights

- The Attention Training Technique improved children's ability to delay gratification
- The effects were greater than those for relaxation or no intervention
- Attention training improved verbal inhibition compared to no-intervention
- The results have implications for enhancing children's self control