The Impact of Achievement Goal States on Working Memory*

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Abstract

The present study examines the influence of achievement goal states on working memory under varying executive load. Seventy-six undergraduate students were randomly assigned to either a mastery-approach condition (goal was to develop self-referential competence), a performance-approach condition (goal was to demonstrate normative competence) or a control condition (no goal assigned) prior to completing the *N-Back* working memory task. Analyses revealed achievement goal effects on working memory under high executive load (3-back) but not under the less demanding loads (1-back, 2-back). Under high load, pursuit of a performance-approach goal resulted in poorer working memory processing than pursuit of a mastery-approach goal or no-goal control. Findings are unlikely to be confounded by cognitive ability, working memory capacity or state-anxiety. Contributions to the motivation-cognition interface and suggestions for future research are discussed.

Key words: motivational states, achievement goal, mastery-approach, performance-approach, working memory, N-Back, motivation-cognition interface

The Impact of Achievement Goal States on Working Memory

Sometimes we are motivated to acquire new skills, while other times we are motivated to prove that our skills are better than someone else's. What does it mean, in cognitive terms, to be motivated in such ways? The interplay of motivational states and cognitive processes – such as encoding, storage and retrieval of information – has attracted substantial research interest (Friedman & Forster, 2001; Graham & Golan, 1991; Weiner & Walker, 1966). Contrasting with some early cognitive approaches that reduced motivation and emotion to information processing (Nisbett & Ross, 1980; Ross, 1977), the distinct role of non-cognitive variables is now demonstrated through thriving research at the motivation-cognition interface (Maddox & Markman, 2010; Revelle, 1993). This research has shown, for instance, that incentive-based states enhance cognitive control (Savine & Braver, 2010), and that appetitive states impact upon attentional focus (Gable & Harmon-Jones, 2008). Such findings have contributed much to our understanding of how two differently motivated individuals might differ in terms of the cognitive processes engaged during goal pursuit. The aim of the present paper is to add to this literature by examining how qualitatively different motivational states – specifically, having a goal to develop skill versus to demonstrate skill – might impact differently upon working memory.

In the achievement motivation literature (Dweck, 1986; Elliot, 1999; Nicholls, 1984), motivational foci are thought to create different perceptual-cognitive frameworks when engaging in learning activities. A motivated focus on the development of self-referential competence (i.e., developing skills) is known as a *mastery focus*, whilst a motivated focus on the demonstration of normative competence (i.e., demonstrating skills) is known as a *performance focus*. Although this founding two-factor conceptualisation has dominated the literature, an additional distinction concerns motivational direction (Elliot, 1999; Elliot & Church 1997; Elliot & McGregor, 2001). That is, one can be motivated to approach (i.e., strive to increase) normative or self-referential competence, or, alternatively, to avoid decrements in these competencies. The present research is concerned specifically with the influence of mastery-approach and performance-approach on working memory. Also, while many researchers conceptualise these foci as individual differences variables, namely *goal orientations* (VandeWalle, 1997; VandeWalle, Brown, Cron, & Slocum, 1999), our focus is upon motivational states, namely *achievement goals*, which are elicited by particular cues, settings or instructions (e.g., Chen, Gully, Whiteman, & Kilcullen, 2000) (see Elliot, 2005). Despite their conceptual similarity, previous research has dissociated these trait and state constructs (Chen et al., 2000; Kozlowski, Gully, Brown, Salas, Smith, & Nason, 2001; Ward, Rogers, Byrne, & Materson, 2004). Although we are specifically concerned with the relationship of state achievement goals to working memory, we also account for the potential influence of trait goal orientation on this relationship. In sum, the present research examines the influence of state mastery-approach and state performance-approach goals on working memory processing.

Working memory, a storage system involved in the maintenance and manipulation of goal-relevant information (Baddeley, 2002; Baddeley & Hitch, 1974; Engle, 2002), has been argued to play a critical role in goal-directed behaviour (Miller & Cohen, 2001). Although very little research has addressed the impact of achievement goal pursuit on working memory, broader investigations of the impact of motivational states on working memory processes are informative. For example, a specific and difficult goal (e.g., “recall at least 18 out of 24 words”), relative to an non-specific goal (i.e., “do your best”) or no goal, has been found to enhance working memory scanning speed and also to facilitate working memory capacity (Wegge, Kleinbeck, & Schmidt, 2001). Monetary rewards have also been found to improve working memory capacity, relative to no-incentive conditions (Heitz, Schrock, Payne, & Engle, 2008). Additionally, research has shown that participants primed with achievement motive words (e.g., master, compete, achieve) prior to performing executive processing tasks perform better than those primed with neutral words (e.g., carpet, window, hat) (Bargh, Gollwitzer, Lee-Chai, Barndollar, & Trötschel, 2001; Hassin, Bargh, & Zimerman, 2009). These effects are typically more pronounced at higher cognitive loads, which may implicate information processing, rather than mere storage capacity, as of importance for goal directed behaviour. Overall, there is substantial evidence that motivational states, broadly construed, impact upon working memory. However, considerably less is known about how the kind of competence-related goal one pursues (i.e., a mastery-approach versus a performance-approach goal) may influence working memory processing.

It is informative to consider effects of mastery-approach and performance-approach goals on aspects of cognition that may relate to working memory processing. For instance, research has linked mastery-approach goals (relative to performance-approach goals) with superior maintenance of categorisation strategies in recall tasks (Escribe & Huet, 2005), increased likelihood of problem solving strategy transfer (Bereby-Meyer & Kaplan, 2005), and better use of effective task strategies on complex cognitive scheduling tasks (Winters & Latham, 1996). Interestingly, high scores on cognitive scheduling tasks for performance-approach goals have also been found, but typically only under less demanding task conditions (Mangos & Steele-Johnson, 2001; Steele-Johnson, Beauregard, Hoover, & Schmidt, 2000). Research has further shown mixed effects on number of words recalled during immediate and cued tests for these achievement goals (Barker, McInerney, & Dowson, 2002; Graham & Golan, 1991). While performance-approach goals tend to predict task performance, mastery-approach goals have been found to predict task interest (Hulleman, Durik, Schweigert, & Harackiewicz, 2008). Some researchers have suggested that this heightened task interest may reflect deeper task engagement, which may ultimately recruit attention and cognitive processing (Hidi & Harackiewicz, 2000; Hulleman et al., 2008). Finally, research has suggested that that mastery-approach goals broaden attentional focus (e.g., demonstrated by superior accuracy on delayed recognition tests relative to performance-approach goals), while performance-approach goals restrict attention to material essential for task performance (Elliot, Shell, Henry, & Maier, 2005; Murayama & Elliot, 2011). Interestingly, a recurring observation this literature is for differential effects of a mastery-approach and performance-approach focus to emerge under more cognitively effortful conditions (Barker et al., 2002; Graham & Golan, 1991; Murayama & Elliot, 2011; Winters & Latham, 1996). This again encourages the possibility that achievement goals may influence allocation or use of basic cognitive processing resources, such as working memory.

The discussed studies are exceptions to a relative paucity of research examining cognitive processes that are elicited by, or concomitant with, achievement goal states. Even fewer studies have directly examined the relation between achievement goals and working memory. These suggest that mastery-approach goals (relative to performance-approach goals and no-goal control conditions) increase working memory capacity scores (as measured by Reading Span, RSPAN; Daneman & Carpenter, 1980) (DiCintio & Parkes, 1997; Parkes, Balliett, & DiCintio, 1998). On the other hand, self-reported state performance-approach has also been found to predict higher capacity scores, but only when controlling for negative affect

(Linnenbrink, Ryan, & Pintrich, 1999). This is consistent with negative impact of anxiety on working memory performance (Ashcraft & Kirk, 2001; Ikeda, Iwanaga, & Seiwa, 1996; MacLeod & Donnellan, 1993), as well as suggestions that performance-approach goals may elicit negative cognitions (e.g., anxiety and worry) that undermine effective use of cognitive resources (Linnenbrink et al., 1999; see also Pintrich & Schrauben, 1992). Interestingly, analysis of working memory processing errors on RSPAN, rather than capacity scores, indicate fewer errors for participants in a no-goal control condition relative to achievement goal states (Parkes et al., 1998). This suggests that pursuit of such achievement goals might consume attentional resources that would otherwise be necessary for the processing, rather than mere storage, of information in working memory. This might particularly be the case for performance-approach goals, which resulted in more errors than mastery-approach in Parkes et al. (1998).

Many of the studies that have examined effects of motivation states (both achievement goals and broader motivational states) on working memory have problems relating to experimental and statistical control. For instance, there is a lack of use of control groups and manipulation checks, lowering the confidence with which differences between experimental conditions can be clearly interpreted in terms of motivational states. Furthermore, research has often not accounted for ability variables that are strongly related to working memory (Oberauer, Schulze, Wilhelm, & Süβ, 2005). Therefore, it is unclear to what extent motivation-related working memory performance differences are distinct from individual differences in cognitive ability. Also, research concerning the effect of achievement goals on working memory has been restricted entirely to set-based span tasks (Conway, Kane, Bunting, Hambrick, Wilhelm, & Engle, 2005), and therefore to capacity indicators rather than continuous processing indicators of working memory. Employing a continuous processing task would allow for pre-existing differences in working memory capacity to be controlled for along with other relevant individual differences (e.g., cognitive ability). An ideal candidate paradigm for this purpose is the N-Back task (Gevins & Cutillo, 1993). This requires participants to monitor a stream of stimuli and decide for each whether it was presented a given number of positions back in the sequence stream. As such, the task requires continuous monitoring, updating, storing and discarding of items in immediate memory. Research suggests that as N-Back load increases (i.e., as the previous stimuli to be matched to the present stimuli is positioned further back in the sequence stream), the greater the executive load (Baddeley, 2007; Kane, Conway, Miura, & Colflesh, 2007; Owen, McMillan, Laird, & Bullmore, 2005).

To our knowledge, no research has examined the impact of achievement goals on N-Back performance, however some studies have examined the impact of broadly similar motivational manipulations. For instance, one study demonstrated that participants who were told ‘do well as your ability is being assessed’ (denoted the ‘high motivation’ group), rather than ‘this is a pilot task to optimise parameters’ (denoted the ‘low motivation’ group), had faster N-Back reactions times (Bengtsson, Hakwan, & Passingham, 2009). Another study showed that broad approach-motivation states (induced via pleasant video clips) enhanced verbal N-Back performance but impaired spatial N-Back performance (Gray, 2001). Research has also shown the impact of motivational incentives (e.g., monetary rewards versus no reward), across various loads of the N-Back task (Pochon, Levy, Fossati, Lehericy, Poline, Pillon, Le Bihan, & Dubois, 2002; Szatkowska, Bogorodzki, Wolak, Marchewka, & Szeszkowski, 2008). Extending this research to examine the impact of achievement goal states on working memory processing may increase understanding of how, in cognitive terms, motivation drives performance.

To summarise, previous research clearly demonstrates that motivation affects cognition, yet very little research has specifically examined the relations of achievement goals to working memory. This seems surprising given the demonstrated relationships between achievement goals and cognitive processing more generally. Clearly, motivational theory could benefit much from the development of this neglected research area. The present experiment builds upon the limited research that has examined the impact of achievement goal states on working memory, whilst addressing some of the limitations and restricted scope of this previous work. First, we employ a continuous working memory task (numerical N-Back) to permit investigation of working memory processing under varying load. Investigation of load effects seems particularly important given previous indications that the impact of motivation on cognition increases with cognitive demands. This paradigm also allows us to separately account for individual differences in working memory capacity. Second, we experimentally manipulate achievement goals, consistent with the core conceptualisations of achievement goal theory, and provide three types of manipulation checks (specifically, measures of task purpose, goal recall and motivational state). Third, to clarify interpretation of any differences between mastery-approach and performance-approach goals (i.e., whether such differences should be interpreted as impairment versus enhancement), we include a no-goal state control group. Fourth, to guard against competing explanations, we examine any impact our achievement goal manipulation might have on state anxiety. Finally, we confirm the effectiveness of random assignment to experimental conditions through assessment of various relevant control variables such as cognitive ability and trait goal orientation to ensure that these variables do not differ between experimental conditions.

From theory and research reviewed above it is predicted that (1) achievement motivation states will influence working memory processing, that (2) such influence will diverge for mastery-approach and performance-approach conditions, and, (3) that these differences will be most pronounced under high working memory load. The sheer paucity of research conducted in this area to date, along with the interpretative difficulties that characterise some of this research, prevents specific directional predictions.

Method

Participants

Seventy-six University of London undergraduates (56 female) from various disciplines took part in the current research and all were entered into a £100 lottery in return for their participation. In accord with ethical approval guidelines for this study, age was recorded in 1 of 5 ranges (18-25; 26-35; 36-45; 46-55; 56-65) with a modal range of 18-25 years reported by 55.3% of the sample. All participants had normal or corrected to normal vision. Informed consent was obtained prior to participation.

Methods and Measures

Working Memory

Working memory was assessed using a numerical N-Back task programmed using e-prime software (Schneider, Eschman, & Zuccolotto, 2002). The task required participants to indicate whether or not the position of a currently presented stimulus matched the position in which a previous stimulus was presented. Load is varied on this task by increasing the number of positions between the current and previous stimulus; either one (1-back), two (2-back) or three (3-back) positions back in the presentation stream (see figure 1). The test stimuli were single-digit numbers from 1 to 9, presented individually in pseudorandom order. Each number was displayed in the centre of a white background (in black Arial typeface size 48) for 1000 ms, followed by an interstimulus interval of 2750 ms. Participants responded with a 'match' or 'not a match' key press during the 1000 ms presentation of the stimulus using the Z and M keys of a QWERTY keyboard respectively. Participants completed one practice block of each N-Back load (18 trials: 12 non-matches, 6 matches), followed by six fully counterbalanced experimental blocks (2 blocks per N-Back load, each containing 30 trials: 20 non-matches,10 matches). Overall accuracy was calculated by summing the number of correct hits (correctly identifying a 'match') and correct rejects (correctly identifying a 'not a match') per N-Back load.

[Insert Figure 1 Here]

Manipulation of Achievement Goal States

The N-Back was performed in one of three experimental conditions: mastery-approach goal (MAG), performance-approach goal (PAG) or no-goal (NG). Achievement goals were manipulated via instructions that framed the focal task (N-Back) in terms of an explicit normative or self-referential goal. This technique has been shown to be effective in previous research and is highly consistent with previous literature examining the impact of motivational states on cognitive performance (Butler, 1993; Elliot & Harackiewicz, 1996; Elliot et al., 2005; Escribe & Huet, 2005; Mangos & Steele-Johnson, 2001). Participants in the MAG condition read the following instructions prior to starting the first experimental block:

"The purpose of this study is to provide students with the opportunity to improve their own memory ability. As such, your goal whilst performing this memory task is to get

to know the task better by focusing on learning how to detect correct number matches well. Developing your own proficiency on the memory task is the aim of the game!"

In contrast, those in the PAG condition read an alternative set of instructions prior to starting the first experimental block:

"The purpose of this study is to provide students with the opportunity to demonstrate their memory ability in comparison to other students. As such, your goal whilst performing this memory task is to detect as many correct number matches as you can in order to perform better than other students taking part. Being more proficient on the memory task than other students is the aim of the game!"

Participants in the NG condition were not given any further instructions relating to the purpose of the task.

To facilitate the maintenance of induced motivational states, participants in both of the goal conditions were provided with associated goal prompts (via the computer screen) at the start of each block of the task. These consisted of reminders to '*develop their skill at the game*' (MAG) or to '*perform better than other students'* (PAG). Those in the NG control were given no goal prompts.

Control Measures

Trait Goal Orientation. The approach scales from Elliot and Murayama's (2008) Revised Achievement Goals Questionnaire, consisting of 3 items per trait goal orientation dimension, was used to assess pre-existing differences in trait goal orientation amongst the participating students. The mastery-approach orientation scale

(α = .70) consists of items such as “generally my aim is to completely master material I am presented with”, while the performance-approach orientation scale (α = .80) consists of items such as “generally my goal is to perform better than other students”. Participants responded on a scale from 1 (*strongly disagree*) to 5 (*strongly agree*).

Working Memory Capacity. The Operation Span (OSPAN) task (Turner & Engle, 1989) was used to control for individual differences in working memory capacity. OSPAN requires the participant to solve a series of mathematical operations whilst also attempting to memorise unrelated words. Participants view operation strings one at a time and are required to read each string out loud (e.g., “Is (9 ÷ 3) - 2 = 2 ? AUNT”). Operation strings are presented at centre fixation in black New Times Roman font size 48 on a white background. The participant states the mathematical string, followed by verification of the answer (i.e., “yes” or “no”), followed in turn by the word (i.e., “aunt”). Operation strings ranged from sets of two to five (three of each set presented randomly) and once the end of each set was reached participants were required to recall the sequence of words stated. OSPAN scores ranged from 0-42, calculated by summing the total number of recalled words only on perfectly recalled sets. To ensure participants were not trading off-mathematics for word recall, an 85% accuracy criterion on the mathematics was required. This original version of OSPAN is found to correlate with other capacity tasks, be highly reliable and demonstrate good internal consistency (see Conway et al., 2005; Klein & Fiss, 1999).

Cognitive Ability. Ravens Advanced Progressive Matrices (1990) (RAPM), was utilised to control for general reasoning ability. Given that RAPM performance has previously been found to correlate with N-Back performance (e.g., Gray, Chabris, & Braver, 2003) the inclusion of this measure was considered important. Participants are presented with a matrix of geometric patterns with the bottom right pattern missing and are required to select from eight possible options the pattern that correctly completes the overall series of patterns. In a practice round, participants completed 4, of a possible 12, matrices from RAPM Set 1 to familiarise themselves with the task. For the actual test, participants completed 18 matrices from RAPM Set 2 (all odd numbered matrices from the original 36 set), in which matrices were presented in ascending order of difficulty. A manual guideline of 30 minutes is recommended for completion of 36 matrices when conducted under time restrictions, which was reduced to 15 minutes for the current research in accordance with the use of exactly half of the 36 matrices available. Participants recorded their responses on an answer sheet provided by noting, with a number from 1 to 8 per matrix, which of the 8 possible options they thought completed the matrix. Scores were based on the total number of correctly identified missing patterns (0, incorrect; 1, correct).

State Anxiety. It is possible that the effect of the goal manipulations on affect may influence affective states beyond motivation. In particular, it is possible that the specification of normative criteria for the PAG (triggering comparative thoughts in regards to others) may elevate anxiety (Gibbons & Buunk, 1999; Linnenbrink et al., 1999). As such, a 5-item measure drawn from Ryan, Koestner and Deci's Intrinsic Motivation Inventory (1991) was administered after the N-Back. This scale measures the extent to which individuals feel pressure in relation to a target activity. All items were adapted to the task at hand, for example, "I was anxious whilst doing this activity", became, "I was anxious whilst doing this memory task". The 5 items were rated on a 7-point scale ranging from 1 (not at all true) to 7 (very true) with an internal consistency of .77.

Manipulation Checks

Task Purpose. To confirm that participants recalled and understood the goal-related purpose of the task, at the end of the experiment participants were asked to indicate on, a list provided by the experimenter, what the purpose of the task they had just completed was. Options included ‘to provide me with the opportunity to develop my own memory ability’ (MAG), ‘to provide me with the opportunity to demonstrate my memory ability in comparison to other students (PAG), and additionally, ‘I don’t remember the purpose of the memory task’, and, ‘the purpose of the memory task was not made clear to me’ to capture any misunderstanding.

Goal Recall. To confirm that participants recalled and understood the specific goal assigned to them they were also asked to indicate on, a list provided by the experimenter, what specific goal had they been assigned for the memory task. Options included ‘to develop my own proficiency on the memory task’ (MAG), and ‘to demonstrate that I am more proficient on the memory task than other students’ (PAG), and additionally, ‘I was assigned no goal’ and ‘I did not understand the goal assigned to me’ to capture any misunderstanding.

Motivational State. In order to assess whether the effects of the goal manipulations were also reflected in the participants perception of their motivational state, a measure of state achievement goals was also administered. State-adapted forms of the mastery-approach and performance-approach scales from Horvath, Scheu and DeShon’s (2001) Global Goal Orientation measure were utilised. The mastery-approach scale ($\alpha = .72$) consists of 4 items such as ‘The opportunity to learn new things on this memory task was important to me’. The performance-approach scale ($\alpha = .91$) consists of 4 items such as ‘I wanted others to recognise that I am one of the best at this memory task’. Participants read ‘As I started and during the memory task….’ prior to completing the items. Responses were scored on a scale from 1 (*strongly disagree*) to 5 (*strongly agree*). It was made clear to all participants that responses were to be based on the experimental blocks only.

Procedure

Participants were tested individually in a sound proof laboratory. First, written consent was obtained and demographic and trait goal orientation items were completed. Participants then completed the OSPAN and RAPM assessments in a counterbalanced order, after which they were given a 5 minute break (but remained in the testing room). After completing the practice blocks of the N-Back, participants were randomly assigned to an experimental group by reading the relevant instructions for their condition. Participants then began completing experimental blocks at their own pace by following on screen instructions. The experimenter remained in the testing room across all conditions, but sat quietly at the back of the room, out of participant sight. No feedback during experimental blocks was provided so as not to conflict with the goal states being manipulated. After completing the six experimental blocks all participants completed (in counterbalanced order) the questionnaires assessing task purpose, goal recall, motivational state, and state anxiety. (Those in the control group did not complete the purpose or goal recall manipulation check.) Finally, all participants were debriefed and thanked for their participation. This entire procedure lasted approximately 90 minutes.

Results

Manipulation Checks

Chi-square tests of independence revealed that participants' post-task reported purpose, $\chi^2 = 42.333$, $df = 3$, $p < .001$, and goal recall, $\chi^2 = 35.51$, $df = 1$, $p < .001$, was consistent with their experimental condition. This confirmed that participants in both the MAG condition and the PAG condition correctly recalled and understood their assigned manipulations. In terms of motivation states, there were significant differences in reported state mastery-approach across groups, $F(2,73) = 6.334$, $p = .003$, with participants in the MAG condition ($M = 15.72$, $SD = 1.72$) scoring significantly higher in this state than those in the PAG condition ($M = 14.28$, $SD = 2.96$), $t(48)= 2.10$, $p = .041$, and than those in the NG control condition ($M = 13.08$, $SD = 3.04$), $t(49)= 3.80$, $p < .001$). Participants in the PAG condition scored the highest on the state performance-approach scale ($M = 10.28$, $SD = 4.45$) compared to participants in the MAG ($M = 8.68$, $SD = 3.91$) and NG ($M = 8.88$, $SD = 4.54$) conditions, however this did not reach statistical significance, $F(2,73) = 1.02$, $p > .05$.

The lack of a significant difference among groups on state performance-approach may have reflected reluctance by participants to endorse the somewhat disagreeable tone of the items on this scale (e.g., 'wanted to do better than others'). Consistent with this explanation, we found that group differences approached significance for the least disagreeable item (i.e., 'enjoyed the sense of proving my ability in comparison to others'): Those in the PAG ($M = 3.00$, $SD = 1.18$) agreed more strongly with this item in comparison to those in the MAG ($M = 2.12$, $SD = 1.05$), $t(48)= 1.80$, $p = .08$. Supplementary data offered more concrete support for our explanation. Specifically, we found that a measure of trait Agreeableness (from a questionnaire participants had completed as part of a separate study, the Big Five Aspects Scale; DeYoung, Quilty, & Peterson, 2007) was modestly correlated with performance-approach state scores, $r = -.19$, $p = .10$. For participants in the performance-approach goal group, this relationship was strongly significant, $r = -.55$, $p = .004$. To explore this further, we examined goal group differences in levels of state-performance approach at high and low levels of Agreeableness. This yielded a significant effect of goal group at low levels of agreeableness, $F(2,70) = 3.32$, $p = .04$, but not at high levels of agreeableness, $F < 1$, *ns*. Within low agreeableness participants, those in the performance-approach goal group reported significantly higher state performance-approach, relative to the control and mastery-approach groups, $t(33) = 2.95$, $p = .025$. It therefore seems that state performance-approach was significantly elevated in the performance-approach state group, but not for participants who were relatively more polite and agreeable.

In sum, these three manipulation checks offer moderate to strong support for the efficacy of our achievement-goal manipulation. However, supplementary analyses indicate potential biases in the reporting of state performance-approach, which may have attenuated goal group differences on this scale.

Preliminary Analyses

Descriptive statistics for all variables within each goal condition are presented in Table 1. The 5 age ranges were found to be elevated among participants in the MAG group ($M = 2.0$, $SD = 1.3$) in comparison to the PAG ($M = 1.4$, $SD = .64$) and the NG group ($M = 1.7$, $SD = .91$). In addition, pairwise t-tests revealed influences of age on N-Back performance on some loads ($p <$. 05). As such, age was included as a covariate in all main analyses. No effect of gender or block load order was found (all *ps > .30*), and, no group differences for overall accuracy in practice N-Back blocks were identified ($p = .83$) indicating that goal groups did not significantly differ on N-Back performance at baseline. Further analyses revealed that goal groups did not significantly differ on trait mastery-approach ($p = .74$) or trait performance-approach ($p = .85$), cognitive ability ($p = .33$), state-anxiety ($p = .78$), and working memory capacity ($p = .98$). Finally, response latency analyses revealed that all participants became slower to respond to stimuli as N-Back load increased, $F(2,146) = 26.62$, $p < .001$, with latencies for 1-back being significantly faster than for 2-back ($p < .001$), and 2-back being significantly faster than for 3-back (p = .003). This indicates that the manipulation of working memory was effective in terms of its impact on response times. Finally, no difference in response latencies across N-Back loads was observed between goal groups (p = .77).

[Insert Table 1 Here]

Effect of Motivational State on Working Memory

A 3 x 3 mixed ANCOVA was conducted with goal group (MAG, PAG, NG) as the between-subjects factor, N-Back overall accuracy per load (1, 2 and 3-back) as the within-subjects factor, and age as a covariate. There was no significant main effect of goal group, $F(2,72) = 1.89$, $p = .16$. There was a significant main effect for load, $F(2,144) = 9.43$, $p < .001$, with estimated marginal means of 52.10, 44.19, and 36.81 for 1-back, 2-back and 3-back accuracy respectively. Accuracy for all participants decreased as N-Back load increased, with 1-back accuracy being significantly higher than 2-back accuracy, $F(1,72) = 6.28$, $p = .014$, and 2-back accuracy being significantly higher than 3-back accuracy, $F(1,72) = 3.82$, p =.05. There was also a significant accuracy x goal group interaction, $F(4,144) = 3.03$, $p = .02$, indicating that, after controlling for age range, differences in accuracy over the three N-Back loads depended upon assigned goal.

In accordance with predictions, a series of one-way follow-up ANCOVAs revealed no significant effects of goal group for 1-back (p = .56) or 2-back (p = .32) accuracy, but a significant effect of goal group for 3-back accuracy, $F(2,72) = 4.20$, $p = .019$, partial $\eta^2 = .10$. No significant differences in 3-back accuracy were found between participants in the MAG and NG group. However, accuracy was significantly lower for participants in the PAG group (M = 31.50) than those in the MAG group (M

= 38.48), $t(72) = -2.12$, $p = .037$, and than those in the NG group ($M = 40.44$), $t(72) = -2.80$, $p = .007$.

Discussion

The current experiment examined how motivational approach goals differentially impact upon working memory. It was found that provision of a performance-approach goal influenced working memory processing, as shown by poorer N-Back task performance, compared to participants in mastery-approach and no-goal control groups. Consistent with some previous research concerning the impact of this goal state on broader aspects of cognition (Barker et al., 2002; Graham & Golan, 1991; Wegge et al., 2001), this effect was restricted to the greatest executive load of the N-Back (3-back). The pattern of post task manipulation checks confirmed that participants' task purpose, goal recall and reported motivational state corresponded to their assigned achievement goal condition. Self-reported mastery-approach goal focus was highest in the mastery goal group, and self-reported performance- approach goal focus was highest in the performance goal group, however this latter difference was not statistically significant. Supplementary analyses suggested potential biases in responding may have weakened this effect, which was significant among participants with lower scores on a measure of trait Agreeableness. As manipulations did not impact upon state anxiety in this data, observed effects on N-Back performance are unlikely result from worry or nervousness that motivational manipulations can potentially induce. Findings are also unlikely to be confounded by differences in cognitive ability, working memory capacity or trait goal orientation preferences. Overall, results build upon previous research (DiCintio & Parkes, 1997; Linnenbrink et al., 1999; Parkes et al., 1998) to suggest that that achievement goal states impact upon working memory processing.

No task performance differences on 1-back or 2-back loads were observed between experimental groups. This suggests that induced achievement goal states, (compared with a no-goal control condition), do not influence working memory processing when the need to monitor, update, store and discard items in working memory is less demanding. This is fitting with findings that show achievement goals have less impact upon performance in less cognitively demanding conditions in comparison to more effortful conditions (Barker et al., 2002; Graham & Golan, 1991). Furthermore, the fact that an effect was found under the highest N-back load, and not under the less working memory intensive loads, suggests that effects are specific to working memory processing as opposed to more general aspects of task performance (e.g., basic psychomotor performance).

The performance deficit of those induced into a performance-approach state in the 3-back load, relative to mastery-approach and no-goal control conditions, potentially converges with research suggesting that performance-approach goal pursuit is characterised by more superficial cognitive engagement (Bereby-Meyer & Kaplan, 2005; Escribe & Huet, 2005) and typically translates into good cognitive performance under less demanding conditions (Mangos & Steele-Johnson, 2001; Steele-Johnson et al., 2000). Interestingly, previous findings suggest that broad approach-motivation states enhance verbal N-Back performance but impair spatial N-Back performance (Gray, 2001). The present research has shown that qualitatively different kinds of approach goal states have differential effects on N-Back performance. This illustrates the value of investigating different forms of approach states - such as different aims or foci of approach states - for broadening understanding of the motivation-cognition interface.

There was no influence of a mastery-approach goal focus (compared with performance-approach and the no-goal control) on working memory. Although much research has shown the benefits of this motivational state, in terms of superior cognitive strategy use and recall (Bereby-Meyer & Kaplan, 2005; Escribe & Huet, 2005; Graham & Golan, 1991), and working memory *capacity* (DiCintio & Parkes, 1997; Linnenbrink et al., 1999; Parkes et al., 1998), some of these studies failed to include a control group. It is therefore difficult to conclude from these studies whether a mastery-approach goal *enhances* working memory function, or simply does not impair working memory function to the same extent as a performance-approach goal focus. In contrast, the present findings suggest that those focused on developing competence maintain working memory processing under a demanding task condition more effectively than those asked to focus on demonstrating competence, but no more effectively than those who have been assigned no goal at all.

Previous research has clearly demonstrated the cognitive advantages of being in a focussed or heightened motivational state (Bargh et al., 2001; Hassin et al., 2009; Heitz et al., 2008; Wegge et al., 2001). The present findings appear in stark opposition to this, as those in a no-goal control condition enjoyed the highest average overall accuracy across all three N-Back loads. Given that the no-goal control group reported the lowest state levels of mastery-approach and performance-approach it is difficult to attribute their superior performance to self-adopted achievement goal states. It is therefore possible that representation of an assigned achievement goal consumes working memory resources, the extent which may depend on the motivational focus on that goal (i.e., to develop versus demonstrate competence). Previous research demonstrating benefits of assigned motivational goals above no goal assigned provided very specific target based goals (i.e., ‘recall at least 18 out of 24 words’;

Wegge et al., 2001), whereas the current achievement goal inducements targeted task purpose and goal focus (i.e., ‘develop your ability.…by learning how to detect number matches well’. Future research within this achievement motivation-working memory framework might therefore compare the effects of these general achievement goals with specific goals.

Previous researchers (e.g., Linnenbrink et al., 1999) have suggested that performance-approach disrupts the *use* of working memory resources through heightened anxiety. The present research however found no differences between achievement goals groups on reported state anxiety. Of course, given that state-anxiety was measured post task completion, and thus framed as experienced anxiety across all three loads of the N-Back task collectively, it is not known whether state-anxiety *within* loads differed for each experimental group. An alternative interpretation can be drawn from the work of Kanfer and Ackerman (1989), who suggest that attentional resources can be selectively allocated to achieve current goals. Accordingly, it is possible that performance-approach states influence selective reliance on available attentional capacity, rather than disrupted allocation. Unfortunately it is difficult to confidently draw this conclusion from the present results, as although the N-Back task assesses working memory processing (rather than capacity), present data would not enable working memory strategies to be selectively identified. Thus for this research area to progress, investigations which allow for a detailed task analysis of working memory paradigms are necessary.

Although the pattern of task purpose, goal recall and motivational state checks indicated successful inducement of state mastery-approach and performance approach, participants in the performance-approach condition did not report being significantly higher in this state in comparison to those in the other two conditions. It is possible that participants were reluctant to report that they wanted to ‘outdo others’ or that they wanted to be ‘recognised as having the best memory ability’. Such statements are arguably less agreeable or desirable than reporting a desire to simply ‘get better at the task’. This explanation is encouraged by the fact that near significant group differences were observed on an item of the state performance-approach scale that evaluated the experience of performance-approach (i.e., a ‘ sense of enjoying trying to do better than others’) rather than directly asking participants if they wanted to outperform others. Analyses also showed that trait agreeableness influenced the reporting of state performance-approach. Specifically, among those participants scoring relatively low on Agreeableness (who may have been less averse to affirming somewhat disagreeable statements), state-performance approach was significantly higher in the group assigned that goal. It is possible therefore that group means on state performance-approach were somewhat compressed due to biases in responding. This would also account for why participants in this condition recalled and understood their assigned task purpose and goal. If biases did indeed influence the reporting of performance-approach scores, this potentially raises more general concerns about the utility of state achievement goal measures, which have not been extensively evaluated in the literature.

The aim of this research was to specifically investigate the impact of *approach* motivated goals on working memory processing. Obviously, further research may additionally consider the impact of *avoidance* states on working memory as well as other aspects of cognition (e.g., breadth of attention; Gable & Harmon Jones, 2010). For example, it would be interesting to assess whether mastery-avoidance goal pursuit engages working memory resources in a similar manner to mastery-approach. Importantly, it has been suggested that when pursuing approach-based achievement goals it is likely that individuals can switch to avoidance, and that multiple goals which combine both mastery and performance elements can also be pursued on task (see Brophy, 2005). Clearly, consideration of avoidance based achievement goals and of the interactive effects of achievement goals in relation to working memory is essential in order for this research area to progress. In fact, the pattern of means observed on the post task motivational state manipulation checks in the present research illustrate the need for future research to investigate multiple goal pursuit, as greater overall reported experience of state mastery-approach relative to performance-approach was evident across all experimental conditions.

In conclusion, the present research has shown that induced achievement goals influence working memory processing. Pursuit of a performance-approach goal seems to result in poorer processing under higher working memory load in comparison to pursuit of a mastery-approach goal and to no assigned goal. This performance-approach deficit is unlikely to be confounded by individual differences in cognitive ability, working memory capacity or state-anxiety induced by the goal manipulation. The present results chime closely with previous research which has found that performance-approach goals prompt less effective cognitive strategies, as well as for why superior performance-approach performance is often limited to less cognitively demanding situations (Bereby-Meyer & Kaplan, 2005; Escribe & Huet, 2005; Winters & Latham, 1996). Limitations of the present work include external validity, in terms of generalisability of these findings to some of the applied contexts in which achievement goals are typically studied (e.g., the workplace or the classroom). On the other hand, the central role of working memory in learning and performance in such contexts is well known. As such, our finding that working memory is influenced by simple instruction-based motivational inducements, common in many real-world environments, highlights the need for further research in this area.

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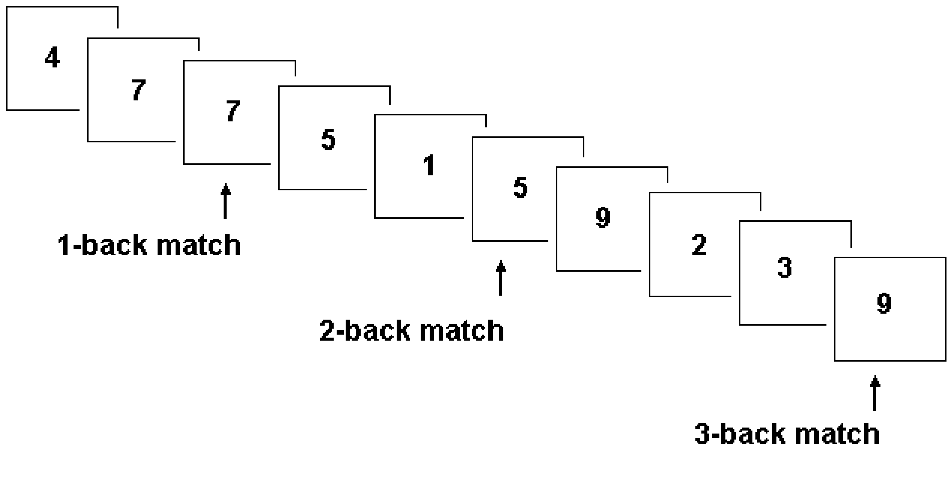

Figure 1. Integrated trial example of number matches from a 1-back, 2-back and 3-back load condition.

Table 1. Means and Standard Deviations for Study Variables by Goal Condition

	Mastery-Approach		Performance-Approach		No-Goal Control	
	M	*SD*	*M*	*SD*	*M*	*SD*
Trait Mastery-approach	12.80	2.00	13.12	1.53	12.77	1.79
Trait Performance-approach	10.20	3.21	10.64	3.29	10.60	3.19
Cognitive Ability	10.76	3.45	10.20	2.67	11.46	2.85
Working Memory Capacity	18.44	10.04	17.84	10.74	18.00	11.02
State Anxiety	16.56	6.10	16.20	5.60	15.40	6.47
1-back:						
Average Reaction Time	649.96	89.37	681.25	82.13	649.31	83.45
Correct Hits	17.32	3.68	17.00	4.03	17.88	3.17
Overall Accuracy	51.24	10.08	51.56	7.45	53.50	7.97
2-back:						

Average Reaction Time	689.77	91.97	713.11	88.53	674.34	81.10
Correct Hits	14.12	3.97	13.12	4.56	15.23	4.04
Overall Accuracy	43.12	12.51	42.44	12.20	47.00	9.74
3-back:						
Average Reaction Time	721.38	86.98	733.47	96.97	697.03	74.87
Correct Hits	10.76	4.81	8.16	4.38	11.04	4.43
Overall Accuracy	37.92	13.11	32.16	10.19	40.35	10.66

Note: Mastery-Approach, N= 25; Performance-Approach, N= 25; No-Goal Control, N= 26. Means are not adjusted.