Evidence for the effectiveness of holistic process goals for learning and performance under pressure

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Abstract

Objectives: Research has suggested that holistic process goals might help avoid the effects associated with conscious processing of task relevant information by skilled but anxious athletes. This experiment compared the efficacy of holistic and part process goal strategies for novices using a learning paradigm. Design: Laboratory-based experimental design incorporating practice, retention and transfer phases. Method: Twenty-four males were randomly assigned to a part process goal, holistic process goal or control condition and performed a simulated race-driving task in practice, retention and transfer tests. Results: Analyses of variance revealed that performance during practice was similar in all conditions but that the holistic process goal group outperformed the part process goal group at both retention and transfer. Conclusions: Compared to part process goals, holistic process goals result in more effective motor learning and performance that appears to be more robust under pressure.

Keywords: goal setting, attention, learning, competitive anxiety
Process goals, learning and pressured performance

Introduction

Process goals specify the behaviors, skills and strategies that are essential for effective task execution. According to Kingston and Hardy (1997), process goals can help performers deal with high anxiety by providing them with a means of focusing their attention on important aspects of performance, such as technique, movement form, self-regulation or strategy. When focused upon technique or movement form, process goals encourage performers to focus on specific aspects of a task using explicit knowledge about the task. This represents something of a paradox in the context of Masters’ (1992) conscious processing hypothesis (CPH), which predicts that a focus on part of a movement underpinned by explicit knowledge (i.e., a process goal) might disrupt the normal automatic task processing of skilled performers (Mullen & Hardy, 2010). Such conscious control of movements is normally associated with the early stages of learning. Kingston and Hardy (1997) suggested that one way of dealing with this apparent paradox is to tailor process goals according to the skill level of the performer. Less able performers might use part process goals that focus on key elements of performance; for example, a novice golfer might focus on a firm but relaxed grip of the club when putting. In contrast, more skilled individuals might use more global, holistically focused cues to conceptualize the whole of a movement, thus avoiding conscious processing effects. An example of a holistic process goal might be a golfer using “Smooth” to conceptualize the feeling of the whole movement while putting. Critically, holistic process goals also differ from an external focus of attention (Wulf, 2007), as a holistic focus involves concentrating on the feeling of the movement itself, in effect an internal focus, while an external focus involves a focus on the environmental effect produced by a movement. An additional advantage of using part and holistic goals to examine the CPH is that their use controls for attentional explanations of anxiety effects. Both types of goal can
be thought of as using equivalent amounts of attentional space, even though the sub-actions they control differ in magnitude.

Although researchers have started to examine the utility of process goals (e.g., Gucciardi & Dimmock, 2008; Jackson, Ashford, & Norsworthy, 2006), the findings from these studies are inconsistent. Mullen and Hardy (2010) claimed that these mixed results do little to clarify the part process goal paradox. Consequently, in three experiments they compared the effectiveness of part and holistically focused process goals, predicting that skilled but anxious performers who used a holistic process goal would outperform those who used part process goals, and also that part process goals would lead to performance impairment. The results were consistent across all three experiments; a single holistic process goal helped maintain or improve performance in the high anxiety conditions. The prediction that part process goals would disrupt task execution under pressure was less clear as, in all three experiments, performance did not significantly deteriorate from baseline (low anxiety) levels, but performance was significantly impaired relative to participants who used a holistic process goal. Mullen and Hardy argued that as participants who used a part process goal did not experience the same performance benefits as those using a holistic process goal, this relative impairment was evidence that conscious processing was activated. A more critical interpretation would be that a single part process goal does not activate conscious processing but instead helps maintain performance in stressful situations (cf. Jackson & Willson, 1999).

It might also be possible that the type of process goal adopted in stressful situations interacts with other moderating variables, such as perceived control or self-confidence, to impact positively on performance, although this suggestion remains unexplored.

The focus of the research conducted so far has been exclusively on the use of process goals by skilled but anxious performers. To date, no research has examined the relative effectiveness of part and holistic process goals for the acquisition of motor skills by novices.
in unpressured practice situations and the subsequent transfer of those skills to competitive conditions where cognitive state anxiety is likely to be elevated. In terms of skill acquisition, there are at least two possibilities. Specifically, novices might benefit from using a part process goal that focuses attention on a key aspect of performance, for example, to focus on following through in the direction of the pass when kicking a soccer ball. During the early stages of learning more holistic representations of a skill might be redundant as the novice is still consciously controlling a skill. As expertise develops, however, holistic process goals might become more important as more skilled performers are able to use the global representation of the movement to avoid lapsing into conscious processing (Kingston & Wilson, 2009). Alternatively, a holistic process goal used early in learning might accelerate the acquisition of a skill by encouraging a more automatic type of functioning, similar to the effect of analogy learning on motor performance (Masters & Poolton, 2012). Analogies allow learners to label instructions and movement instructions symbolically, thus avoiding the accrual of explicit knowledge about how to perform a movement. However, holistic process goals are different to analogies as the latter are symbolically coded while the former are coded kinaesthetically (Mullen & Hardy, 2010). In this study, we predicted that holistic process goals would accelerate the learning novices. Further, and in line with the existing evidence, we also predicted that after a period of learning, driving performance would be more robust under competitive pressure in participants who had acquired the skill using holistic process goals relative to their counterparts who learned using part process goals. This study also set out to address one of the limitations evident in previous work by including a control condition to examine how effective part and holistic goals are relative to discovery learning, where participants are allowed to search the motor workspace naturally, without direction (Vereijken & Whiting, 1990). Previous work has also focused primarily on discrete
motor skills such as golf putting or basketball free throwing. The present study extends this focus by using the continuous skill of simulated race car driving.

Method

Participants
Twenty-four male undergraduate students between 19 and 23 years of age ($M = 19.58$, $SD = 1.89$) were recruited from a university in the United Kingdom. Participants reported no experience of the driving game used in the study, had been in possession of a full UK driving license for at least one year ($M = 2.04$ years, $SD = 0.70$), and provided informed consent. Ethical clearance was obtained from the university ethics committee.

Apparatus and Measures

Race simulator. Participants completed a driving simulation task using the Gran Turismo™ computer game (Sony; Foster City, CA) presented on an 81cm screen. Participants used an analogue force feedback steering wheel and pedals and drove around a track with 12 bends in a Mazda MX5 with automatic gear changes. Participants used the driver’s perspective to perform the task and drove in time trial mode to avoid any confounding effects of other cars on track. Driving performance was assessed using lap times, recorded by the computer software, and the number of driving errors made. An error was made if two or more wheels left the track, if the car hit a wall or barrier, or if the car spun.

Cognitive state anxiety. State anxiety was measured using the cognitive anxiety subscale of the revised Competitive State Anxiety Inventory-2 (CSAI-2R; Cox, Martens, & Russell, 2003). The CSAI-2R is a sport-specific, self-report inventory that has been shown to be a valid and reliable measure of cognitive and somatic anxiety and self-confidence by Cox et al.
Only the cognitive anxiety subscale was used in line with Eysenck, Derakshan, Santos and Calvo’s (2007) assertion that the cognitive component of anxiety is primarily responsible for the effects of anxiety upon performance. Participants rated their cognitive anxiety on a Likert scale ranging from 1 (not at all) to 4 (very much so). Item responses were summed, divided by 5 and multiplied by 10, resulting in a score range of 10 to 40 (Cox et al., 2003).

Modifications were made to the orienting instructions at the beginning of the CSAI-2R and some of the questions to reflect the fact that the baseline anxiety condition was a practice condition. The standard instructional set and questions were used for the competitive transfer condition. For the present study, Cronbach’s alpha coefficients indicated adequate internal consistency for the CSAI-2R cognitive anxiety subscale (alpha = .76).

**Manipulation check.** Participants in the holistic and part process goal groups were asked whether they believed they had maintained their assigned focus, requiring a yes or no response. Participants who responded negatively were asked an open-ended question to determine what they perceived the issue to be.

**Design**

Participants were tested on three consecutive days. The first two days comprised the practice phase of the study, during which participants completed eight blocks of two trials (1 trial = 2 laps). Four blocks were completed on day one and four on day two. The third day consisted of two blocks completed in a retention condition, followed by a further two blocks in a competitive transfer condition designed to elevate cognitive state anxiety. In total, each participant completed eight blocks of two trials (32 laps) during the practice phase, and two blocks of two trials (8 laps) in both the retention and transfer conditions. Each trial consisted of 24 bends, so in total, participants completed 384 repetitions of the steering task during practice, and 96 repetitions during both retention and transfer tests.
Experimental conditions

Participants were randomly assigned to one of two process goal conditions or a control group and received written instructions detailing the cue that they were required to use while steering around bends. Accordingly, there were 8 participants in each group. The goals were constructed with the assistance of two sport psychologists in line with driving instruction literature (Bentley & Langford, 2000). The process goals focused on hand movements in both conditions in order to avoid the potentially confounding effect of an internal versus external focus of attention (Wulf, 2007). The steering ratio was low enough to ensure that participants did not have to alter their grip in order to complete any of the turns. In addition, participants in all conditions were instructed to keep their vision focused on the track at all times during the task.

Holistic process goal group. Participants were instructed to focus on using the hands to turn the steering wheel smoothly when negotiating bends using the cue smooth turns. Importantly, the focus here was using hand movements to make the turn as efficiently as possible.

Part process goal group. Group members were instructed to focus on using the outside hand to negotiate bends in the most efficient way. For a left hand bend, this meant that the right hand (outside hand) primarily turned the steering wheel, while the left (inside) hand merely followed the movement. Participants were asked to use the cue outside hand to guide their hand movements.

Control group. Aside from instructions regarding visual focus, participants in the control group were given no specific guidance as to how they should steer.

Procedure
Participants were asked to refrain from practicing similar tasks between testing sessions. Participants attended the driving simulator individually and were told that the researcher was interested in the effects of concentration on a simulated driving task. All of the participants were asked to drive around the track as quickly and efficiently as possible.

**Practice.** On day one, participants completed five orienting laps, and then read instructions about their assigned goal, which they used for the duration of the study. Participants then completed two warm up laps of the track using their goal before the practice trials. Participants were reminded to use their goal before each acquisition block. On completion of the second acquisition block, participants received a three-minute break. After the four acquisition blocks, participants completed the manipulation check. For day two, participants repeated the procedure from day one but did not undergo familiarization. During the three-minute break following the second block, participants completed the cognitive anxiety measure to establish state anxiety levels in a non-threatening condition.

**Retention and transfer.** Preliminary procedures on day 3 were the same as day 2. Following two warm up laps, participants then completed two blocks of driving in the retention condition. After a three-minute break, participants received instructions informing them that they were involved in a competition and that they had been assigned to a two player team (cf. Beilock & Carr, 2001). Participants were told that the winners would be the team who produced the fastest aggregate lap time, that individual and team times would be posted publicly and that both members of the winning team would win £10. Individual target times were assigned to participants, giving them a false time that they were told they had to achieve in order for their team to have a chance of winning the task. The target times were calculated by taking the participant’s fastest lap time from practice minus 1.5 seconds. Pilot testing had indicated that this target was perceived as challenging but realistic and also that the competition scenario was important from both a personal and team perspective, thus creating
an ego-threatening situation that would increase cognitive state anxiety levels. Following two
warm up laps, participants again completed the CSAI-2R, and performed two blocks of
driving. Participants were then fully debriefed and given the monetary reward regardless of
their performance.

Data Analysis

Practice lap times and the number of errors were analyzed using two-factor mixed model
analyses of variance (ANOVA; 3 x 8; Group x Block). Significant effects were followed up
using Tukey HSD pairwise comparisons. To confirm that learning had occurred for all
participants, two contrasts compared performance for all of the groups at baseline (block 1)
with performance in the retention and transfer conditions. Retention and transfer data were
analyzed using one-way ANOVA and significant effects were followed up using Tukey HSD
tests. Cognitive state anxiety was analyzed using two-factor mixed ANOVA (3 x 2; Group x
Anxiety Condition, with repeated measures on the second factor). Partial eta squared was also
calculated; effect sizes of .02 are considered small, .15 medium, and .35 large (Cohen, 1988).

Results

Manipulation check

Three participants, one from the part process goal group and two from the holistic process
goal group, indicated that they had difficulty use their assigned cue on day one of the study.
Responses to the follow up question revealed that all of these participants occasionally “lost
focus” and briefly forgot about their process goal but believed that their focus was quickly
regained. As a precaution, statistical analyses were run with and without the problematic
participants. The results were identical and the full data set is reported here.

Practice
The equivalency of initial driving performance was assessed using one-way ANOVA. No group differences were found for lap times, $F(2, 21) = 2.14, p > .05$, or number of errors, $F(2, 21) < 1$. For lap times, large within-group variance in all groups during block 1 contributed to this non-significant effect. Mean values for practice, retention and transfer phases are shown in Figures 1 and 2. For the practice phase, Greenhouse-Geisser adjusted degrees of freedom were used to test within-subject $F$ ratios as the sphericity assumption was violated for both lap times and number of driving errors. The main effect for group for lap times approached significance, $F(2, 21) = 3.01, p = .07, \eta_p^2 = .20$, and this was likely to be attributed to the slower times produced by the part process goal group. The main effect for group for number of errors was not significant, $F(2, 21) < 1, p > .05, \eta_p^2 = .06$. Neither of the Group x Block interactions were significant $F(5.08, 53.30) < 1, \eta_p^2 = .08$, and $F(5.08, 53.30) < 1, \eta_p^2 = .05$, for lap times and number of driving errors, respectively. The main effect for block for lap times was significant, $F(2.54, 53.30) = 30.18, p < .001, \eta_p^2 = .59$, indicating that there were significant improvements across the practice trials. This pattern was reproduced for the number of driving errors, $F(7, 147) = 30.18, p < .001, \eta_p^2 = .59$.

**Retention and Transfer**

To confirm that learning had occurred, and based upon the absence of a significant main effect for group and Group x Block interaction during practice, two simple contrasts were used to compare performance of all of the groups at (i) retention and (ii) transfer with performance in block 1. Both contrasts were significant for lap times, (i) $F(1, 21) = 75.19, p < .001, \eta_p^2 = .78$, and (ii) $F(1, 21) = 77.09, p < .001, \eta_p^2 = .79$; and number of driving errors, (i) $F(1, 21) = 36.71, p < .001, \eta_p^2 = .64$, and (ii) $F(1, 21) = 44.26, p < .001, \eta_p^2 = .68$. 

**INSERT FIGURES 1 AND 2 ABOUT HERE**
Retention. For lap times, the one-way ANOVA was significant, \( F(2, 21) = 4.50, p < .05, \eta_p^2 = .30 \). Tukey HSD pairwise comparisons revealed that the holistic process goal group recorded faster lap times than the part process goal group. No other comparisons were significant. There was no significant difference between the groups for the number of driving errors, \( F(2, 21) = 2.32, p > .05, \eta_p^2 = .18 \), indicating that the faster lap times were not achieved at the expense of accuracy.

Transfer. There was no significant Group x Anxiety Condition interaction or group main effect, both \( Fs < 1 \). The main effect for anxiety approached the .05 significance level, \( F(2, 21) = 3.01, p = .07, \eta_p^2 = .22 \). The associated effect size of .22 confirms the practical effectiveness of the anxiety intervention. Mean values (\( \pm SD \), low to high anxiety condition) were: holistic process goal group, 19 (4.14) to 20.75 (5.44); part process goal group, 17 (3.85) to 20.75 (4.27); control, 18 (6.14) to 21.75 (5.50). One-way ANOVA on lap times yielded a significant difference between the groups, \( F(2, 21) = 3.57, p < .05, \eta_p^2 = .20 \). Post hoc tests indicated that the holistic process goal group was faster than the part process goal group, with no other differences significant. The groups did not differ significantly on the number of errors made, \( F(2, 21) < 1, \eta_p^2 = .08 \), replicating the effect found at retention.

Discussion

The purpose of this experiment was to establish whether holistic process goals, relative to part process goals and discovery learning, would enhance (i) the acquisition of a simulated race-driving task, and (ii) performance of that task under competitive pressure. As predicted, the holistic process goal group outperformed the part process goal group at both retention and transfer. The results for discovery learning were less clear as performance in the control group was no different from either the holistic process goal or part process goal groups at
retention and transfer. This effect was not evident during the practice phase, as all three groups improved similarly.

The absence of any clear practice benefits for the holistic process goal group supports findings elicited with similar tasks in related research into external and internal attentional focus. For example, Wulf, Hoß, and Prinz (1998) found that an external attentional focus did not impact on participants performing a stabilometer-balancing task until retention. More importantly, in this experiment there was a clear advantage at retention and transfer, which supports the utility of holistic process goals over part process goals for both learning and performance under pressure. All of the previous research examining holistic process goals has adopted performance paradigms to compare holistic and part process goals in low and high anxiety conditions (Gucciardi & Dimmock, 2008; Jackson, Ashford, & Norsworthy, 2006; Mullen & Hardy, 2010), with no attention paid to how effective these goals might be for motor learning. The advantage demonstrated by the holistic process goal group over the part process goal group at retention is the first evidence to show that holistic process goals may be more effective than part process goals for the acquisition of motor skills. The superior performance of the holistic group over the part group at transfer adds further support to the work of Mullen and Hardy (2010) and Gucciardi and Dimmock (2008), who also provided evidence that holistic process goals or global task cues are superior to part-focused goals in conditions where anxiety is elevated.

There is the possibility that the nature of the instructions given to both process goal groups may have contributed to the group differences found at retention and transfer. It could be argued that the part process goals might have engendered more of an internal focus (cf. Wulf, 2007) compared to the holistic process goals; however, we suggest that both types of goal promoted an internal focus by focusing on the hands. Despite this, the instructions to the part process goal group to focus primarily on using the outside hand to induce a steering effect
could possibly have disrupted the natural dynamics of what is, in effect, a bimanual task
(Kelso, Southard, & Goodman, 1979). Instructions to use a holistic focus or discovery
learning may have promoted a more natural tendency to use both hands as part of a single
 coordinative structure to explore the dynamics of the task in a more effective manner. We
have no evidence to support this suggestion and future research should consider examining
joint dynamics to explore this possibility.

The performance of the discovery learning control group at retention and transfer is also of
interest, as it did not differ significantly from either the part or holistic process goal groups.
However, the failure to include the control group in any kind of manipulation check has
limited the extent to which we can comment on their performance relative to the process goal
groups. It would be important to clarify the focus of the control group in future research.
While the inclusion of the manipulation check strengthened the design of the present study in
comparison with similar research that has failed to adopt such procedures (e.g., Wulf, 2007),
the binary nature of the participants’ response did little to illuminate the extent to which
participants perceived that they had adhered to their instructions and limits the strength of our
findings.

The study was not without further limitations. The anxiety effect only approached
significance. Replicating real world stressors in laboratory conditions is always problematical
and our anxiety manipulation, which consisted of competition, financial incentive, and social
evaluation attempted to combine several features of interventions used in previous studies
(e.g., Beilock & Carr, 2001; Mullen & Hardy, 2010) to maximize the predicted anxiety
effect. Evidence presented by Mesagno, Harvey and Janelle (2011) has indicated that self-
presentation may be a key feature of manipulations designed to increase anxiety.
Consequently, our manipulation may have benefitted from additional features to increase
participants’ self-presentation concerns, for example, use of a video camera and an audience.
Although the sample in the present study was relatively small, group size does correspond those used in similar learning and pressure studies (e.g., Masters, 1992). Furthermore, Jackson and Willson (1999) have previously demonstrated that participants who use self-selected goals outperform those who use assigned goals. However, in this study the participants were novices and assigned goals were used, as participants might not have possessed sufficient task knowledge to select or formulate meaningful and relevant process goals at the beginning of the learning phase. Future research should also seek to add to the evidence provided here by examining process goals using different tasks across a wider range of populations. Researchers should also explore the attentional mechanisms associated with the use of both types of process goal.

This experiment extends the literature suggesting that holistic process goals are more effective than part process goals for skilled but anxious performers. The results indicate that holistic process goals are more effective than part process goals for motor learning. Although it appears that holistic process goals proffer no performance advantage during practice, the benefits realized at retention suggest that such goals should be preferred to part process goals, which result in weaker learning and also appear to lead to less robust performance under pressure.

References


