"Decisions, decisions, decisions": Transfer and specificity of decision making skill between sports

Joe Causer & Paul R. Ford

Brain and Behaviour Laboratory, Faculty of Science,

Liverpool John Moores University, Byrom Street,

Liverpool L3 3AF, UK

RUNNING HEAD: Decision making transfer

Please address correspondence to:

Dr Joe Causer

Brain and Behaviour Laboratory

Faculty of Science,

Tom Reilly Building

Byrom Street

Liverpool

L3 3AF

Tel - +44 (0) 151 9046242

Email – j.causer@ljmu.ac.uk

Abstract

The concept of transfer of learning holds that previous practice or experience in one task or domain will enable successful performance in another related task or domain. In contrast, specificity of learning holds that previous practice or experience in one task or domain does not transfer to other related tasks or domains. The aim of the current study is to examine whether decision making skill transfers between sports that share similar elements, or whether it is specific to a sport. Participants (*n* = 205) completed a video-based temporal occlusion decision making test in which they were required to decide on which action to execute across a series of 4 *vs*. 4 soccer game situations. A sport engagement questionnaire was used to identify 106 soccer players, 43 other invasion sport players, and 58 other sport players. Positive transfer of decision making skill occurred between soccer and other invasion sports, which are related and have similar elements, but not from volleyball, supporting the concept of transfer of learning.

Keywords: cognitive processes, knowledge, skill acquisition, perceptual-cognitive skill

A key part of expert performance in many fields, such as sport, law enforcement or medicine, is successful *decision making* (for reviews, see Dhami 2003; Causer and Williams 2013; Tenenbaum 2003; Klein 1997; Williams and Abernethy 2012; Dicks et al. 2009). Decision making is defined as the ability to use information from the current situation and the knowledge possessed about it so as to plan, select and execute an appropriate goal-directed action or set of actions (Willams and Ford 2013). Decision making appears to be an acquired ability (e.g., Ford et al. 2010; Roca et al. 2011), but researchers are yet to investigate whether decision making ability in one domain can transfer to successful decision making in another related domain. The aim of the current study is to examine whether successful decision making is specific to a sport or whether it transfers between sports that are related and have similar elements.

The concept of transfer of learning holds that an individual who acquires successful performance in one task or domain can transfer that successful performance into another task or domain (Duncan 1953). Thorndike (1914) was one of the first to consider the concept of transfer of learning through his notion of *identical elements*. These elements can be motor, perceptual or conceptual variables, and tasks with similar elements are expected to allow greater transfer between them. For example, soccer and rugby contain similar elements, such as the perceptual elements of tracking the ball in flight, suggesting transfer of these elements can occur between the two sports. In contrast, elements or attributes acquired in one domain that do not transfer to another domain suggests specificity of learning.

A few researchers have started to examine perceptual and motor transfer (e.g., Rienhoff et al. 2013), but there is a lack of research investigating whether decision making ability can transfer between related domains. Some researchers

have investigated whether pattern recognition and recall skills, which may be related to decision making skill, transfer between related sports. For example, Smeeton, Ward and Williams (2004) compared the pattern recognition skills of skilled and less-skilled players from soccer, field hockey and volleyball in structured and unstructured scenarios across each of the three sports (*n* = 6 players in each of 6 groups). Sports with similar elements (soccer and field hockey) were expected to transfer pattern recognition skill across their sports, whereas those with fewer shared elements (volleyball) were not. Contrary to previous research (e.g., Chase and Simon 1973) participants were faster and more accurate on *unstructured* compared to *structured* pattern trials. There were no significant findings for response accuracy. However, partial evidence for transfer of learning was found for response time as skilled soccer and hockey players were faster at recognizing structured soccer and hockey clips when compared to volleyball players, whereas volleyball players responded faster to clips from their sport compared to the other sports. No other parts of the interaction or study provided support for transfer of learning.

In a similar study, Abernethy Baker and Côté (2005) compared pattern recall skill across 15 expert (3 netball, 8 field hockey, 4 basketball) and 10 intermediate netball, basketball and field hockey players. Players viewed six video clips twice for each sport and were required to recall, upon occlusion of the video on the second viewing, the positions of the players on screen. The percentage of player positions correctly recalled was the primary dependent variable but it did not differentiate groups for any of the sports. The descriptive statistics and effect sizes were forwarded to suggest that domain-specific experts were more accurate at recalling player positions in their own sport when compared to the other participants, whilst in some cases in partial support for transfer of learning the experts from other sports

were more accurate compared to intermediates in their own sport. It is possible that the relatively long duration of video clips may have enabled all groups to recall player positions to the same level of accuracy regardless of sports, especially since the three sports share many similar elements.

The studies above provide, at best, partial support for the transfer of learning hypothesis. However, the pattern recall skills examined by Abernethy et al. (2005) are simply a test of memory and are not part of the decision making process during dynamic goal-directed performance (for a review, see Ericsson et al. 2000). Consequently, it is decision making that is central to expert performance in dynamic goal-directed domains and it is on this variable that experts would be expected to excel and, therefore, should be measured. Moreover, the studies of Abernethy et al. (2005) and Smeeton et al. (2004) contain small sample sizes for groups, relatively low numbers of analysed trials, and unexpected differences or lack of differences, which all suggest a lack of statistical power. For example, in Smeeton et al. (2004) the unstructured clips unexpectedly produced greater accuracy to structured clips, whereas in Abernethy et al.(2005) there were no differences in accuracy between skill groups. Additionally, it is debateable whether the between-group differences in these studies are statistically meaningful (for a review, see Atkinson and Nevill 2001). The percentage differences in group means amount to less than *one* recalled player (Abernethy et al. 2005) or 1 second or less in response times that ranged from 6 to 7.5 seconds (Smeeton et al. 2004). Further research is required with larger sample sizes in order to investigate whether decision making skill, as opposed to recognition and recall skills, transfer between related domains.

The aim of this study is to examine whether decision making ability is specific to a sport or whether it transfers between sports that have similar elements. Skilled

and less-skilled participants from three sporting groups (soccer, other invasion sports and other sports) completed a soccer-specific decision making test. Invasion sports are defined as those that require teams to score points in goals and lines positioned at the end of the pitch behind the opposition team (e.g., soccer, basketball, gridiron), whereas other sports include athletic, racket and target sports, such as tennis, golf, athletics (Launder 2001). In line with the concept of transfer of learning, it was expected that expert participants from soccer would be better at decision making compared to those from other unrelated sports, although not compared to those from other invasion sports because those sports are related and have similar elements.

Method

Participants

Participants were 205 undergraduate sports science students (aged 20 $\pm$ 0.8 years; male = 155, female = 55) recruited from the School of Sport and Exercise Sciences undergraduate body at Liverpool John Moores University. All procedures were conducted in accordance with the ethical guidelines of Liverpool John Moores University, UK. A sport engagement questionnaire based on that used by Ford et al. (2010) was used to identify 106 soccer players, 43 other invasion sport players (e.g., basketball, hockey, rugby union), and 58 other sport players (e.g., tennis, golf, athletics). In each of the three sport classifications, participants were divided into skilled (regional, national, international) and less-skilled (school, local club, college) based on their highest level of performance.

Procedure

Participants completed a video-based temporal occlusion decision making test in which they were required to decide on which action to execute in a series of 4 *vs*. 4 soccer game situations. The task was very similar to those used previously to

examine decision making in soccer (Helsen and Pauwels 1992; Williams and Davids 1998; Roca et al. 2011). The participants viewed soccer footage that was life-size on a large video screen (1.5 m wide x 1.5 m high, 0.50 m from floor to bottom of screen). Videos were viewed from the first person perspective of a back player of the team who were in possession of the ball, who was not shown on the video. The participant was required to play the role of the back player for the team in possession. Figure 1 shows an example of a video clip frame demonstrating the viewing perceptive of the participant. Each video clip started with a player in the participant's team in possession of the ball. During the clip, the player in possession passed the ball towards the participant as the other players moved around the pitch. Each video clip ended when a white screen occluded the video on the frame in which the ball reached the participant. The white screen remained for four seconds. During this time, participants were required to select the option they would execute based on the situation on screen prior to occlusion for one of five soccer actions (shoot, pass to left, pass to centre, pass to right, dribble). The final situation on screen always contained at least one of these options. Participants completed four warm-up trials and 28 experimental trials.

Data analysis

A panel of three Union of European Football Associations (UEFA) qualified soccer coaches watched all clips and selected the most appropriate decision/action for a player to execute in the final situations on screen. There was 100% agreement between the coaches as to the decision/action to be executed across trials. Each participant was awarded a point for each correct answer in the decision making task when their answer corresponded to that selected by the coaches. A total score was calculated for each participant and expressed as a percentage for the primary

dependent variable of response accuracy. A two-way, between groups ANOVA was used to analyse response accuracy score with sport type (soccer players, other invasion sport players, other sport players) and expertise (skilled, less-skilled) as the between groups factors. Significant effects were followed up using Tukey *post-hoc* testing. The effect sizes were calculated using partial eta squared values (η_p^2) and Cohen's *d* as appropriate. The alpha level for significance was set at 0.05. If the sphericity assumption was violated, the Huynh-Feldt correction was used.

Results

There was a significant main effect of sport type on response accuracy ($F_{1,196}$= 100.43, P< 0.001, η_p^2 = 0.51). Response accuracy for soccer players (72 $\pm$ 10 %) and other invasion sport players (70 $\pm$ 9 %) were significantly higher compared to the other sports players (53 $\pm$ 8 %) (d = 2.11). There was no significant difference in response accuracy between soccer players and other invasion sport players (d = 0.21) (see Figure 1). There was a significant main effect of expertise on response accuracy ($F_{1,196}$= 9.27, P = 0.003, η_p^2 = 0.05). Response accuracy for skilled athletes (68 $\pm$ 14 %) was significantly higher compared to the less-skilled athletes (65 $\pm$ 11 %) (d = 0.24). There was a significant interaction between sport type and expertise for response accuracy ($F_{2,196}$= 4.40, P = 0.01, η_p^2 = 0.04). *Post hoc* analysis revealed that response accuracy for soccer players was significantly higher for skilled (77 $\pm$ 8 %) compared to less-skilled players (69 $\pm$ 10 %) (d = 0.89). Response accuracy for other invasion sports players was also significantly higher for skilled (72 $\pm$ 8 %) compared to less-skilled players (67 $\pm$ 8 %) (d = 0.63). There were no significant differences for response accuracy between skilled (53 $\pm$ 12 %) and less-skilled (52 $\pm$14 %) players in other sports (d = 0.07).

Discussion

The aim of this study is to examine whether transfer of decision making accuracy occurs between sports or whether this ability is specific to a sport. In support of the transfer of learning hypothesis, it was predicted that skilled participants from soccer would not be more accurate at decision making compared to those from other invasion sports, but will be compared to those from other sports, which do not share similar elements.

As predicted by the transfer of learning hypothesis, the soccer group were *not* more accurate at decision making compared to the other invasion sports group. Data supports the transfer of learning theory because there was no difference in response accuracy on the decision making test between groups from related sports with similar elements. The response accuracy data support and extend the hypotheses of Smeeton et al. (2004) and Abernethy et al. (2005) by showing positive transfer of decision making skill between sports with similar elements. Moreover, as expected, response accuracy was greater for the soccer and other invasion sports groups compared to the other sports group. Data supports the specificity of learning theory to some degree as decision making was more accurate for groups from the invasion sports compared to unrelated other sports that have different elements. The response accuracy data support the hypothesis of Smeeton et al. (2004) who hypothesised that positive transfer of decision making skill would be impaired between sports that have different elements.

Although findings illustrate the possibility that decision making accuracy may transfer across sports with similar elements, at no point did athletes perform better on a related sport when compared with their corresponding performance on the primary sport. Therefore, we should not surmise that practice in a related sport (e.g. rugby union) might be better for developing decision making compared to engaging

in the primary sport (e.g. soccer). Moreover, it might be that although some elements of a sport may transfer across similar sports, there might be more idiosyncratic, sport-specific elements that are only developed by training in the specific sport.

The specific mechanisms that enable transfer of learning to take place are not well understood. Acquired visual search behaviors that are specific to the sport have been shown to underpin successful decision making and different search behaviors are observed between expert and less-skilled performers (Causer and Williams 2013). It is possible that acquired visual search behaviors may transfer between sports that contain similar elements. Moreover, some mechanistic neural evidence has started to emerge from the motor learning literature, demonstrating that previous learning can expedite learning in a transfer condition (Seidler and Noll 2008). Specifically, motor transfer has been associated with brain activation in areas such as the right cingulate gyrus, left superior parietal lobule and bilaterally in the cerebellum, which are thought to be involved in late learning and storage. Findings suggest that transfer of learning requires the retrieval of previous acquired motor representations, which expedites the early stages of learning in the transfer task (Seidler 2010). It is possible that a similar mechanism is involved in the learning and transfer of decision making skill. For example, it may be that engagement in a sport enables the individual to develop well-refined representations in long-term working memory (Ericsson and Kintsch 1995), which, when transferred into a sport with similar elements, can be minimally adapted in order to allow the individual to respond accurately. Future research should look to examine the mechanisms underpinning transfer of decision making skill, and the potential methods to expedite skill learning/transfer.

In summary, positive transfer of decision making skill occurred between soccer and other invasion sports, supporting the concept of transfer of learning, but not between invasion and other sports, providing some support for specificity of learning.

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Figure Captions

Figure 1. An example of a frame from the video-based decision making test off 4 *vs*. 4 soccer game situations, which demonstrates the viewing perceptive of the participant.

Figure 2. Response accuracy (%) in the soccer decision making task for skilled and less-skilled soccer players, other invasion sports players and other sports players

Figure 1
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Figure 2
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