8 Letting the social and cognitive merge

New concepts for an understanding of group functioning in sport

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Introduction

In recent years, researchers have been re-examining how extant concepts in sport psychology can account adequately for the functioning of groups in sport (e.g. Eccles and Tenenbaum, 2004, 2007; see also the 2006, Volume 4, special issue of the *International Journal of Sport and Exercise Psychology*). A particular concern has been that the existing research on sport groups such as teams and organisations has predominantly involved only social concepts. Furthermore, when it has involved cognitive concepts, the focus has been on understanding the cognitive processes mediating the performance of an individual performer within a group, but seldom those mediating the performance of the group. While each of these perspectives has provided important insights into group functioning in sport, the proposal in this chapter is that the current understanding of this topic could be enhanced substantially by a perspective that involves an integration of both social and cognitive concepts.

Thus, this chapter is concerned with a social-cognitive perspective on group functioning in sport. This perspective, as it is explicated in the chapter, is based on concepts that originate in disciplines other than sport psychology. These concepts have been concerned with understanding how humans, animals, or humans and technological agents function effectively in collaborative, goal-directed groups. These disciplines include biology, cognitive science, human factors and ergonomics, industrial and organisational (I/O) psychology, philosophy, social-cognitive psychology and sociology. It is proposed that a consideration of the social-cognitive concepts presented in these disciplines has relevance for the study of group functioning in sport.

The chapter begins with a discussion of the contributions and limitations of the extant research on group functioning in sport. Following this, there is an overview of key concepts relating to a social-cognitive perspective on group functioning that have the potential to enhance the current understanding of group functioning in sport. Next, these concepts are used to interpret the functioning of a real-world sport organisation, which involves a national orienteering squad's preparation for major competitions. Finally, implications of a social-cognitive perspective on group functioning for best practice in sport are proffered, and future research directions related to this perspective are suggested.

Contributions and limitations of the extant research on group functioning in sport

This section involves a discussion of how group functioning in sport has been considered predominantly from a social perspective, and how researchers interested in cognitive aspects of sports performance have been concerned predominantly with the individual performer. Following this discussion, there is an attempt to articulate some specific limitations of these perspectives with regard to accounting for group functioning in sport.

The predominance of a social perspective on group functioning in sport

To date, when the individual has been the unit of analysis in sport psychology, researchers have considered both cognitive and social processes. For example, there is an extensive literature within sport psychology on cognitive processes underlying individual performance, especially skilled performance (Starkes and Ericsson, 2003; Williams and Hodges, 2004). Furthermore, there has been much concern with how social processes, such as social support, influence individual performance (e.g. Rees *et al.*, 1999). However, there has been less consideration for how an individual's cognitive processes might be affected by the social processes inherent to the social group in which the individual is almost always embedded (Collins, 1996). As will be argued in more detail later, this embeddedness exists even if the individual's sport is individual in nature. Furthermore, a cursory analysis of current introductory texts on sport psychology is enough to reveal that, for the most part, when the unit of study involves more than one individual, an interest in cognitive processes disappears, leaving only an interest in social processes. For example, the text by Weinberg and Gould (2003) includes four chapters related to the topic of group processes, which are respectively entitled group and team dynamics, cohesion, leadership and communication. The chapter on group and team dynamics covers concepts such as group development, group norms, team climate and social loafing within groups. With regard to creating an effective team climate, the authors describe how the existing research has provided some support for how social support, team-members' perceptions of their team's distinctiveness and the extent to which coaches treat players fairly affect team climate. Thus, these concepts are predominantly social in nature, and this perspective is reflected throughout the current research literature on group functioning in sport.

The predominance of the individual as the unit-of-analysis in studies of cognition in sport

Current studies of the cognitive processes mediating sport performance have focused predominantly on individual performance. Key texts (e.g. Starkes and Ericsson, 2003; Williams and Hodges, 2004) and reviews (Hodges *et al.*, 2007;

Williams and Ward, 2007) relating to this topic provide evidence of this individual focus. These works have considered how perception, attention and memory processes operate to mediate an individual's performance, and how these processes change as a result of practice and experience so that a higher level of performance is achieved. For example, the review by Williams and Ward (2007) provided evidence that, as athletes develop in sport-team settings, they are better able to search for and identify contextual information in their environment, which, in turn, allows them to better anticipate the upcoming actions of team-mates and opponents and thus prepare earlier and more appropriate responses to those actions.

Limitations of traditional perspectives on group functioning in sport

The following anecdote is useful in illustrating the limitations of the traditional perspectives on group functioning in sport (Eccles and Tenenbaum, 2007). In the Rugby Union World Cup final in 2003, England and tournament host Australia were tied at 17–17 in the final 25 seconds of the game. In a breathtaking finale, Matt Dawson spun the ball out of the England's line-out to Jonny Wilkinson. While under great pressure, Wilkinson dropped the ball to his feet and executed a stunning drop-goal to clinch the game and seal England's name in the history books as the first northern-hemisphere side to win the World Cup. After the game, Wilkinson was asked to reflect on his drop-goal. His response was, "We had a clear routine of how we'd get a drop-goal. It just went absolutely like clockwork. That's why you win these big games" (British Broadcasting Corporation, 2003).

From a research standpoint, there are various questions that might be asked in an attempt to understand how the "routine" Wilkinson described is achieved. Who created the routine? What was the process by which it was created? How many people on the team needed to learn the routine? Did they need to understand the entire routine or just that pertaining to how they contributed to it? If they didn't really contribute to it, how much about it, if anything, did they need to understand? If all the players who needed to know the routine did not help create it, how was the created routine communicated to those players who were not part of its creation? Was the timing of the routine within the game planned prior to the game or did it emerge in a more self-organised way? Alternatively, was it initiated by one or more than one member during the game and, if so, how? Was it through communication? If so, from whom and in what form? How was it decided which person should undertake the communication? Was it through conventional authority (e.g. was the communicator the captain) or by planning prior to the game? For Eccles and Tenenbaum (2007), and for the authors of this chapter, answers to most if not all of these questions seem to require the consideration of both social and cognitive concepts and, more specifically, the allowance that these concepts merge (Eccles, 2007; Giere and Moffat, 2003).

However, there have been few attempts to consider such a perspective. To elaborate, concepts from cognitive psychology are infrequently applied at the

group level. For example, Levine *et al.* proposed that cognitive psychology "has traditionally been a psychology of the individual" and "little attention has been paid to ... cognitive functioning in interaction with others" (1993: 586). The limitations of the traditional individual perspective on cognition are made clearer when it is considered that the human is a social animal that exhibits a propensity for interpersonal interaction that is rarely paralleled in other species. Hutchins (1991) suggested a test to exemplify such interaction. From where you sit, try to identify an object that is not the product of human collaboration. The present authors suggest a similar test: identify the number of different types of groups, teams and larger organisations (e.g. family, work and social) within which you are a member. It is usually harder to identify activities undertaken solely as an individual. Thus, as the poet John Donne asserted (Carey, 2000), few of us are "islands". Consequently, we rarely think in a "social vacuum" (Levine *et al.*, 1993: 586). By contrast, we are firmly embedded in a society and culture that constrains and shapes our thought-processes. Despite this, social and cultural factors have essentially been "set aside as problems to be addressed after a good understanding of individual cognition has been achieved" (Gardner, 1985; Hutchins, 1995a: 353).

However, researchers in various disciplines have called for an acknowledgement of the impact of social structures and processes on human cognition. In the cognitive sciences, researchers have argued that even when an individual is engaged in a solely individual activity, that individual's cognition is still affected by the social network and cultural context within which he or she operates (D'Andrade, 1981; Resnick *et al.*, 1996). Collins asserted that the "neglect of the social embeddedness of both humans and computers" is what limits the capabilities of intelligent machines (1996: 103). In sociology, a major topic is human agency, which describes the extent to which humans can think and act in ways independent of the social structures in the environment (Lukes, 1977). In biology, it is understood that "processes such as thought, perception, emotion, and even memory, are usually shared events within tribal, family, and community groups. Exceptions are rare and sometimes celebrated, but do not represent the customary basic mode of human experience" (Goerner and Combs, 1998: 126). Given that social and cognitive factors seem to interact to affect group performance, and that sport psychologists have proffered that organisational, social, and cultural perspectives might enhance the understanding of the psychology of sports performance (Woodman and Hardy, 2001), the next section involves an overview of key concepts relating to a social-cognitive perspective on group functioning.

A merging of social and cognitive concepts

This section comprises a discussion about how social and cognitive concepts might be merged to create a social-cognitive perspective on group functioning that has the potential to enhance the current understanding of such functioning in sport. While social cognition is a broad area, the key social-cognitive

concepts that could relate to group functioning in sport can be parsed into two sub-areas (Eccles and Tenenbaum, 2007). The first sub-area concerns the effects of social processes inherent within groups on an individual group member's cognition. For example, evidence has been provided that an individual's cognitions can be influenced by expectations associated with the role that the individual is allocated within a group or team (for reviews, see Eccles and Tenenbaum, 2007; Kerr and Tindale, 2004; Levine *et al.*, 1993). The second sub-area concerns group- and team-level cognition, which relates to cognition arising specifically in the context of group and team interaction. The section that follows is focused on this second sub-area, as we believe it offers the most opportunities to advance the current understanding of group functioning in sport.

The division of labour

A central concept related to an understanding of how collaborating living systems function is the division of labour. As anyone who has ever watched a group of ants carrying a large object will know, "many hands make light work" (or legs, in the case of the ants). There are two key aspects to the concept of the division of labour. First, it is possible to divide labour so that similarly skilled group members (e.g. members with similar muscular endurance) are each allocated labour of a similar quality (e.g. shovelling sand) so that the group can undertake and accomplish a task involving labour demands greater than any one individual group member can supply. Second, it is possible to divide labour so that differently skilled group members (e.g. a quarterback and running back in American football) are each allocated labour of a different quality (e.g. the quarterback is allocated throwing, and the running back carrying the football).

It is this second aspect of divided labour that can dramatically enhance a group's capabilities. A central theme in economics, sociology and biology is the notion that a group's productivity is greater when the different types of labour the group must undertake are allocated so that each type is undertaken by an individual (or individuals) specialised in those types than when all group members partake in all types of labour equally. In biology, the division of labour among specialised organisms is thought to increase reproductive fitness. Biologist Tschinkel asserted that, for humans, "it is the division of labour within groups that makes us so scary – we call these groups corporations, armies, teams, hunting parties, posses, agencies, assembly lines, or factories" (2006: 273). Human societies increasingly cultivate specialisation of their members as means of increasing their fitness. Consider, as did sociologist Durkheim (Jones, 1988), that our education systems constrain us to specialise. Our governments attempt to predict and redress shortfalls in specialist areas to retain national fitness. For example, recent predictions that current decreases in US science, technology, mathematics and engineering expertise will reduce US competitiveness in the global economy have prompted the United States Congress to attempt to address this shortfall (National Academy Press, 2007).

The division of cognitive labour

Theorists have introduced the notion of the division of labour into the cognitive realm to explain how the cognitive labour involved in mediating some tasks is divided among group members (Cannon-Bowers *et al.*, 1993; Hutchins, 1995a; Rouse *et al.*, 1992). Consider, for example, how the control of a rally car is cognitively mediated during the race by two collaborating group members: the driver and co-driver. The driver is allocated the task of driving the car. The co-driver is allocated the task of interpreting and reading aloud to the driver pace notes, which contain information about the nature of the upcoming road (e.g. a sharp left turn is approaching). Considering only the attentional demands associated with the control of the car, neither the driver nor co-driver alone could attend to driving and to the pace notes as carefully as when both driver and co-driver work together, as anyone who has tried to drive a car and attend to a map in an unfamiliar town knows. Indeed, the attentional demands associated with map-reading while driving or piloting are the rationale for much research on electronic "head-up" navigational displays (Eccles *et al.*, 2006; Tufano, 1997).

However, the control of the rally car is not only explained by the division of attentional demands between driver and co-driver but by the differential division of the cognitive labour involved in the control. To elaborate, the cognitions involved specifically with driving are allocated to the driver and with the reading of pace notes to the co-driver, each a relative specialist in his or her own task. Given that driver and co-driver are often quite skilled at each other's tasks, performance is likely to be better when the driver reads the pace notes and the co-driver drives (equal labour division) than when driver or co-driver alone tries to drive and read pace notes (no labour division). However, performance in either scenario is likely to be far inferior to a scenario in which the driver drives and co-driver reads the pace notes, given their respective specialities (differential labour division).

While this is a hypothetical scenario, the division of cognitive labour among group members has been studied in a variety of real-world tasks. An early example of some advantages of the equal division of cognitive labour was offered by Shaw (1932). Individuals or groups of four students at New York's Columbia University were asked to undertake a range of now-classic problems including the "cannibals and missionaries" and "Tower-of-Hanoi" problems. An attempt was made to trace the groups' solution protocols by listening to the intra-group communication and by observing and recording the groups' manipulations of the problem stimuli. A key finding was that groups solved many more problems than individuals. The protocol data indicated that the groups' superior performance was in large part due to the effect of incorrect ideas proposed by one group member being rejected by another group member. By contrast, external checks of this kind were unavailable to the individual working alone.

More recently, Hutchins, a recipient of the coveted MacArthur "genius" grant, offered several real-world examples of the advantages of the differential division of cognitive labour. Hutchins studied the division of cognitive labour

in maritime ship navigation (1995a) and aircraft cockpit teams (1995b). The study of maritime ship navigation teams revealed that a fundamental task required for ship navigation is to record the spatial relations between the ship and the world. One such relation is the angular position of the ship at sea relative to a landmark. Hutchins (1995a) described how several personnel are responsible for the processing of navigational information from its initial encoding using the ship's alidade (a type of compass), to its plotting on the ship's navigational chart, and to its final use in actually controlling the ship.

Cognitive affects of social organisation and communication in groups

Researchers studying the division of cognitive labour in groups have asserted that the cognitive properties (or capabilities) of groups are determined by a range of social factors that extend beyond the division of cognitive labour among group members to include the group's social organisation (e.g. whether it has a hierarchy) and its communication (e.g. who can communicate with whom) (Hinsz *et al.*, 1997; Hutchins, 1991, 1995a). Thus, while the group members in two groups might be identical in terms of the knowledge they possess and their capacity for information processing (i.e. for perceiving, attending to, encoding and retrieving information), the cognitive properties of the two groups will be different if the groups differ on any of these dimensions.

Roberts (1964), a cultural anthropologist, provided an example of these concepts. He studied four Native American tribes to identify, for each tribe, how information was retrieved from the tribe when it was needed for problem-solving. The tribes were pre-industrial and non-literate and so information was not stored within the tribes via artefacts (e.g. books). Thus, information important to problem-solving was located only within the memories of the tribal members. Roberts concluded that some tribes were more efficient than others at storing, retrieving and utilising such information for decision-making and that the determinants of a tribe's efficiency were organisational and communicational in nature. These included tribe size, the distribution of information between tribal members, and the patterns and time course of the interactions between members.

Closely related to the notions proposed by Roberts is Wegner's (1986) transactive memory theory. Stated succinctly, transactive memory is concerned with knowledge about "who knows what" (Moreland and Argote, 2003: 135). More formally, it is "a set of individual memory systems in combination with the communication that takes place between individuals" (Wegner, 1986: 186). Central to transactive memory theory is the notion that an individual does not need to know a target piece of information to be able to access it if he or she knows of, and is able to easily access, the location of that piece of information in the external environment. The external environment includes objects such as books and other individuals.

Within established social networks, individual members not only develop a sophisticated awareness about what knowledge is held by other individuals

(i.e. the locations) but also have well-established channels of communication with those members so that access to that information is efficient, rapid and reliable. This produces a knowledge "holding" and access system that is larger and more complex than any of the memory systems of the individual members of the social network (Wegner, 1986: 189). Retrieval of information within an established transactive memory system may be a complex process. Wegner (1986) provided an example of this complexity. A boss is asked for information about which she has no idea but thinks her secretary might and so asks the secretary. The secretary might know where the information is located and can access it and provide it to the boss. However, even if the secretary does not know the location, he may know that he provided it to the boss when she asked for it a week earlier and may remind the boss of this episode. This reminder may function as a retrieval cue that allows the boss to access the item either internally from memory or externally, perhaps from a file cabinet. Thus, transactive memory systems provide an example of how an individual's membership within a social organisation, and the social structure of that organisation, can affect the individual's cognitive (specifically memory) capabilities.

Hutchins (1991) used connectionist models of group cognition to explore how confirmation biases in decision-making in a group could be affected by the social organisation of the group. Confirmation bias is defined as the tendency to stick with prior interpretations of a situation and discount any disconfirming evidence. The motivation for the creation of the models arose from an actual shipping accident. The accident occurred after members of the ship's crew appeared to have reinforced beliefs amongst themselves that a nearby ship was sailing away from the crew's ship. By contrast, the nearby ship was actually being sailed towards the crew's ship. Even while holding the cognitive properties of the individuals comprising the two teams constant, the models showed that teams can possess different cognitive properties depending on the nature of the communication within the team. They also showed that, in some circumstances, confirmation bias can be exacerbated at the group level compared to the individual level.

Another area of research that has provided evidence of the effects of social processes within a group on that group's cognitive properties involves the distribution of decision-relevant knowledge among group members. Stasser and Titus (1985) showed that two members of a group must hold the same piece of information for it to be discussed by the group. If the information is only available to one member of the group, it tends to be treated as mere opinion and is therefore less likely to be discussed. However, when more members hold that information, those members tend to provide social support for each other regarding the value of the information. This process appears to be accentuated by time pressure, such that shared information receives attention early during discussion, but unshared information is mentioned relatively late in discussion. The problems arising from time pressure are suggested to play a role in information-processing biases in groups.

Adler and Rodman (2002) proposed a solution to this problem. They suggested that there would be more discussion of information held by only one

group member if groups adopted a simple rule that allowed each group member a certain amount of uninterrupted time to introduce and discuss his or her ideas. This provides an example of how a change in the structure of the social processes of a group can potentially affect that group's cognitive capabilities.

The challenges of coordinating the division of cognitive labour

A particular problem for groups in which members have at least partial autonomy is coordination (Eccles and Groth, 2006a, b, 2007; Eccles and Tenenbaum, 2004, 2007). A dictionary definition of "coordination" is "the regulation of diverse elements into an integrated and harmonious operation" (Dictionary.com). Furthermore, the term "coordination" is etymologically distinct from the terms "collaboration" and "cooperation", which are often used erroneously as synonyms with coordination within and beyond the I/O literature on teamwork (Fiore and Salas, 2006). Coordination is derived from three separate concepts – arrange, order and together – which, when applied to the domain of teamwork, can be conceptualised as "the appropriate sequencing and integration of team inputs" (Fiore and Salas, 2006: 371). When this definition is applied to groups, it is each member's labour and, more specifically, the operations each member undertakes, that represent these "elements" or "inputs". Members' operations must be sequenced or integrated in a timely way to form a composite of the operations that achieves satisfactory performance.

The importance of coordination is made clearer following a consideration of the evidence that individual performance within groups actually decreases as group size increases. Steiner's (1972) conceptual framework of group productivity proposed that the potential for group productivity increases with group size, owing to the extra resources provided by the extra group members. However, the increase in group productivity decreases with each additional member, until productivity reaches a plateau so that any increase in membership has no additive effect on productivity. Steiner (1972) called the loss of per-person productivity *process loss*, and the loss of productivity resulting from poor coordination specifically has become known as a *coordination decrement* (Fiore *et al.*, 2003). Clearly, the full potential of the human resources available within a team are wasted when process losses occur. Following Steiner's work, Hackman and Morris have proposed that attempts to increase coordination in groups are actually less concerned with increasing the group's productivity than with "minimizing inevitable process losses" (1975: 64).

An unpublished but classic study by Ringelmann (cited in Kravitz and Martin, 1986) provides an example of Steiner's predictions. Ringelmann studied group tug-of-war performance wherein the addition of group members increased group productivity but decreased individual efficiency. Steiner (1972) proposed that one reason for the loss of efficiency was decreases in personal accountability, which are known to accompany increases in group size. Such decreases cause a reduction in individual motivation and an increase in social loafing. The social loafing account of Ringelmann's findings is now often

considered as the only one proposed by Steiner. However, Steiner also proposed that increases in group size present challenges to achieving coordination within the group.

The relationship between group size and coordination is exponential if every group member's operations must be coordinated with every other member's operations. If the coordination of operations between two group members is considered a coordination link (Carron and Hausenblas, 1998), the number of coordination links for a given group size is determined by the following formula:

$$\text{coordination links} = N\,(N-1)/2 \quad (1)$$

where N equals the number of group members. If two people crew a sailboat, there is only one coordination link between group members, but if eight people crew the same sailboat, providing four times the resources, there is the potential for 28 coordination links.

Consider a hypothetical model in which (a) each member of a group must coordinate his or her operations (i.e. form a coordination link) with all remaining group members; (b) the control of the coordination involved in one coordination link involves an equivalent of 10 per cent of one individual's cognitive resources; and (c) the relationship between the resource "cost" of each cognitive resource link and the number of links in a group is linear. Within this model, a sailboat operator who attempts to double the cognitive resources available to crew his boat by recruiting a second crew member will only achieve a 90 per cent increase in available cognitive resources. This is because the formation of the coordination link between the members will impose 10 per cent coordination "overhead" on one member or 5 per cent on both members if the labour is equally divided. Furthermore, an attempt to double cognitive resources in even slightly larger groups will impose a much higher coordination overhead. Doubling the cognitive resources of a four-member crew by recruiting four more members imposes a 280 per cent overhead, equating to 35 per cent per person. This is why even small groups find it useful to appoint a manager (or "skipper" in sailing parlance), a crew member with a specialisation in dealing with coordination and other team-based work, termed *teamwork* in the I/O literature (Eccles and Tenenbaum, 2004, 2007; McIntyre and Salas, 1995). Most of the labour associated with the coordination overhead can be allocated to the manager, leaving the remaining crew members to undertake more of the task-based work, termed *taskwork* in the I/O literature.

In addition to group size, a key factor affecting the requirement of a group to achieve coordination is the type of task being undertaken. While researchers have proposed different classification systems for the types of task that groups typically undertake, such as McGrath's (1984) task circumplex, Steiner (1972) has provided the most explicit descriptions of how the requirement for coordination of a group's activities could depend on the type of task being undertaken. Steiner proposed four types of task in this regard: disjunctive, conjunctive, additive and discretionary (Steiner, 1972). *Disjunctive tasks* are those that only need one group member to be capable of achieving the task. For example, if one

group member can solve a mathematical equation provided as a task to the group, then the group can solve it. Thus, this type of task requires little coordination within the group as group members can work independently to undertake the task. *Conjunctive tasks* lie at the opposite end of a continuum to disjunctive tasks. Thus, conjunctive tasks are those requiring all group members to contribute if the group is to be successful and thus require the group to coordinate its efforts. Conjunctive tasks can be found in team sports. For example, within a rugby union defence that is spread out in a line over the field in defence of its territory, each player must be active in his or her own defending role to avoid penetration of the line by an opponent. An interesting feature of the disjunctive–conjunctive task continuum is that performance is often limited in disjunctive tasks by the competence of the strongest group member – the member that solves the equation fastest – and in conjunctive tasks by the competence of the weakest member – the least-skilled player in the rugby team's defence.

Additive tasks involve group members' contributions being combined by summation to yield a group outcome such as the total annual volume of sales achieved by a sales team where each team member works independently in their own sales territory. Additive tasks can require the coordination of the group's activities but not to the extent required for conjunctive tasks. The coordination demand imposed by *discretionary tasks* can vary because, for this task type, the group has discretion in terms of how to divide labour among its members. For example, project-management teams in business are often self-governing and, thus, when presented with a project, are able to decide how to organise their team structure and allocate tasks across or between team members. As McGrath (1984) noted, many domains, including sports, involve multiple tasks that must be undertaken simultaneously and that differ in terms of the task types proposed by Steiner.

Studies have provided evidence of the challenges associated with such coordination. An early example in the cognitive arena was provided by Thorndike (1938). Thorndike asked individuals and groups of students to undertake various tasks such as completing sentences and limericks, and solving and creating crossword puzzles. Groups outperformed individuals on all tasks with the exception of crossword-puzzle creation. The reason proffered for the groups' relative inferiority on this task was that the creating process was of such a high cognitive demand that sharing a "line" of creative thought within the group required cognitive resources that could be used more productively for developing that line in one's own mind. Consequently, "the group product frequently amounted to nothing but the best individual performance of a member of the group, turned in for the group" (1938: 413).

An early example of the problems associated with group coordination in the motor domain was provided in a study by Comrey (1953), which involved a pegboard assembly task. In an "individual condition", two men sat across from one another at a table. Each man undertook his own pegboard assembly task. Both men were given the same amount of time to complete the task. Immediately

following this, and with the men still seated in their original positions, a "group condition" was created by positioning a board between the two men and asking that they complete overlapping operations as if working on a production line, so that the coordination of their activities was required. Similar to the finding of the tug-of-war study presented earlier, the key finding of the study by Comrey was that, while the absolute performance of a group was superior to that of an individual, it was always less than the sum of the group members' individual performances.

Evidence of the challenge presented by group coordination has also been found in the sports domain. In order to investigate the effects of group size on group cohesion and performance, Widmeyer *et al.* (1990) assigned college students to basketball teams of three, six or nine members who played three-on-three games in a weekly basketball league for a ten-week period. The teams comprised of six members outperformed teams of three and nine. It was asserted that the performance of the teams of three was negatively affected by physical fatigue, whereas the teams of other sizes were able to avoid this problem because they had enough players to rotate in and out of play. The explanation of the relative inferiority of performance by the teams of nine was less clear. However, Widmeyer *et al.* surmised that poor motivation was unlikely. Instead, these authors argued that poor coordination was the most likely explanation, although coordination was not measured.

Control mechanisms mediating the organisation and coordination of the division of cognitive labour

Returning to the example of the drop-kick routine, it is clear that the challenge of achieving effective coordination in groups can be met. What is less clear, however, is how. Few studies have provided insight into the mechanisms that might mediate the control of a group's operations so that coordination can be achieved. A starting point, then, might be to consider the mechanisms that are purported to mediate the performance of *individuals* within group settings. The current research literature on this topic indicates that, as the performer acquires experience and engages in practice, there are gradual increases in the amount of and improvements in the organisation of domain-specific knowledge, as well as rapid and flexible memorisation of, and access to, that knowledge during performance (Ericsson and Kintsch, 1995). These adaptations drive the performer's search of the environment for task-relevant sources of information and afford him or her rapid integration of that information with his or her existing knowledge, the product of which is considered a model (Kintsch, 1988) or profile (McPherson, 1999) of the current situation or event. In team sports that require rapid responses to continually changing, dynamic and open environments (such as football), a key benefit of a performer's ability to construct an elaborate situation model is an improvement in his or her ability to anticipate environmental changes. With regard to coordination, elaborate situation model construction in team sports allows the performer to anticipate changes in the

actions of team-mates and, in turn, more time to select, prepare and execute appropriate responses to those actions (i.e. coordinate their operations; McPherson, 1999; Ward and Eccles, 2006; Ward and Williams, 2003).

The role of planning in the construction of situation models

In group settings, a key source of information used in the construction of group-members' situation models is plans. Several studies (e.g. Comrey, 1953; Kidd, 1961; Naylor and Briggs, 1965) have provided evidence that sources of inefficiency in group settings are not only the result of instances of poor coordination, such as when the individuals in the study by Comrey (1953) simultaneously attempted to place pegs in the same pegboard hole, but also from attempts by group members to rectify problems with coordination. To elaborate, group members in these studies occasionally ceased their operations following coordination problems in order to communicate so that a plan could be constructed about how to avoid these problems and thus enhance coordination on future trials.

Thus, group-level planning seems important for coordination. The dictionary definition of a plan is "a scheme or method of acting, doing, proceeding, making, etc., developed in advance" (Dictionary.com). As labour in groups is often divided according to group-member specialisation, planning involves "developing in advance" of the intended labour a "scheme of proceeding" that specifies the group's goal and who (i.e. which group member) will do what (i.e. which operations) and when, as a means to achieving that goal. Thus, a plan allows each group member to obtain and integrate information into his or her situation model about the nature and timing of the operations he or she is to perform. This facilitates coordination and, in turn, performance (Cannon-Bowers *et al.*, 1993; Rouse *et al.*, 1992; Stout *et al.*, 1999).

However, some scholars have questioned the utility of plans as a resource for structuring behaviour, be it at the individual or group level, in at least some types of tasks (Ward and Eccles, 2006). For example, in open and dynamic task environments that involve multiple degrees-of-freedom, football being the exemplar, plans would seem to be only a very loose resource for group members to use to structure the group's activities. By contrast, performance in these environments would seem to require more online, or so-called "on-the-fly", moment-to-moment adaptations than a plan would permit (Ward and Eccles, 2006). This concern is related to a much larger debate in the cognitive sciences about the utility of plans. For example, Suchman wrote that "the circumstances of our actions are never fully anticipated and are continuously changing around us. As a consequence our actions, while systematic, are never planned in the strong sense that cognitive science would have it" (1987: viii). In Suchman's view, preformulated mental representations of operations such as plans (cf. Miller *et al.*, 1960) are "best viewed as a weak resource for what is primarily ad hoc activity" (Suchman, 1987: ix).

However, implicit in Suchman's view of plans is that they function to structure operations at a relatively specific level. This overlooks the possibility

that plans can structure operations at different levels of abstraction, ranging from general to specific (Eccles and Tenenbaum, 2004, 2007; Hayes-Roth and Hayes-Roth, 1979; Ward and Eccles, 2006). When the function of plans is considered in terms of providing constraints on behaviour (Newell, 1986), plans at the general end of the abstraction continuum provide only a few "loose" constraints on behaviour, but these constraints still function to help achieve coordination in groups. For example, a team plan for a football game may include only a specification of group members' roles: "You two play in defence, you on the right wing, you on the left ..." etc. When Player A is assigned the role of "defender", she is provided with only a few specific constraints on her moment-to-moment selection of operations, which means that she can remain relatively flexible and adapt to the dynamic game situation. Nonetheless, the constraints function to restrict her from selecting most operations related to offensive tactics. Furthermore, if the plan was known to the entire team (i.e. was integrated into each player's situation model), then Player A's team-mates would know that her role was that of a defender, which would place constraints on whether and when they should pass to her in a given situation. Thus, the plan's specification of roles helps the group achieve the desired coordination of divided labour.

General strategies constitute another example of how plans at the general end of the abstraction continuum can provide only a few "loose" constraints on behaviour but nonetheless help achieve coordination. For example, the strategy of attacking down the wings in the first half of a football game provides few specific constraints on team-members' moment-to-moment selections of operations during the game. This means that players can be flexible and adaptive in the specific nature and timing of their attacks. However, the few constraints that are specified by this strategy still function to limit players' attacks down the middle of the field in the first half of the game. Thus, general plans can be used to achieve group coordination in open sports because they specify constraints only at a macro-level of operations, which allows for flexibility and adaptation at a micro-level.

By contrast, plans at the specific end of the abstraction continuum provide many more constraints on the nature and timing of team-members' operations. Thus, specific plans are useful in the coordination of team sports characterised by discrete sequences of operations. American football is an excellent example of a team sport in which a range of plans or "plays" involving relatively "tight" constraints on group-members' operations are devised prior to the game. These are selected by the coach for each phase or "down" of the game in order to coordinate the team's operations during that down. As Wikipedia's entry on "American football" suggests: "Before each down, each team chooses a play, or coordinated movements and actions, that the players should follow on a down" (Wikipedia, http://en.wikipedia.org/wiki/American_football).

However, while American football might operate nearer the specific end of a plan abstraction continuum, this does not mean that team operations in American football are highly constrained; simply that there are tighter constraints on members' operations than in, say, football. There remains the potential for

flexibility even within the relatively tight constraints imposed on a receiver by a receiver-route specified as part of a "play" planned by an offensive coach. This is because the receiver and quarterback do not memorise specific receiver routes to be run. By contrast, they memorise spatial constraints that form the outer boundaries of a spatial "corridor" on the field within which the receiver can adapt in order to evade defensive opponent players or when faced with other similar perturbations.

The shared requirement

Researchers interested in group functioning in I/O psychology have asserted that coordination is more likely to be attainable if information about plans designed to achieve coordination is integrated into each group member's situation model so that the plan is *shared* by all group members (Cannon-Bowers *et al.*, 1993; Marks *et al.*, 2000; Mathieu *et al.*, 2000; Smith-Jentsch *et al.*, 2001; for a review, see Salas and Fiore, 2004). The term "shared" in this instance means to be "held in common" (Dictionary.com). The process of setting up a meeting provides a simple example of the social-cognitive concept of knowledge sharing. Two critical pieces of information that must be not only obtained but also shared by those intending to meet are the timing (i.e. date and time) and the location of the meeting. This is evident in the following text, which represents a typical telephone exchange between the first author and one of his colleagues:

AUTHOR: "Hey, fancy a coffee?"
COLLEAGUE: "Ok, how about, say, half three at [a coffee company] on Tennessee Street?"
AUTHOR: "Um, how about 3:45, I've got a student coming in beforehand?"
COLLEAGUE: "Ok, 3:45's fine, see you then."
AUTHOR: "Will do, see you mate."

Furthermore, some analysis of this exchange also indicates that group members involved in arranging a meeting must reach a second shared state that is meta-cognitive in nature; that is, it involves knowing about what is known (Flavell, 1979). To elaborate, the first shared state relates to knowledge of the plan: each member knows he must meet the other member at the coffee shop on Tennessee Street at 3:45. The second shared state relates to knowledge that the first shared state has been achieved: each member knows that both members are aware that the plan has been successfully shared. The utterance "see you then" by the colleague functions to communicate to the author that the colleague currently understands that the pair are intending to meet at 3:45. Furthermore, the utterance implicitly requests, via social convention in language, that the author confirms (or corrects) this understanding (see Smith, 1977, for similar conjectures). When one individual knows that another possesses some particular knowledge, this is a meta-cognitive state not in a traditional individualistic sense, wherein one knows what one does (or does not) know, but in a

social sense, in that it involves knowledge of another's knowledge. Metacognition in this instance is akin to the concept of transactive memory proposed by Wegner (1986) and described earlier.

In the process of attempting to reach the shared states described, it is possible for group members to achieve the second state without achieving the first. For example, the author could "know" that both he and his colleague know they are meeting for coffee at 3:45, while the colleague could "know" that both he and the author know they are meeting at 3:30. There is little doubt that the reader has at one time or another experienced this situation and, in relation to it, has uttered a statement such as: "I thought we agreed to meet at..." A documented example of this problem occurs in the sport of mountaineering. Mountaineering teams often split up during an expedition, owing to various factors such as team members developing mountain sickness, but arrange to meet at some later time and location. The different subgroups often achieve the second shared state in that each subgroup knows that all subgroups share the arranged meeting time and location, but in reality the arrangements are not shared and thus the first shared state is not achieved. Consequently, the subgroups fail to meet and, believing that the other subgroups have failed to get off the mountain safely, contact a mountain rescue team. Only later is it discovered that all subgroups got off the mountain safely and are worrying about one another from, for example, different cafes. In the words of the rescue services of the Alpine Club of Canada, "A high number of searches result simply from parties splitting up while not coming to reasonable understanding about who is going to do what" (Alpine Club of Canada, n.d.). Thus, it appears that effective communication within groups facilitates the control of coordination via the establishment and maintenance of shared situation models (Cooke *et al.*, 2001; Endsley, 1995; Orasanu and Fisher, 1992).

Communication

One of the strongest sources of evidence for the role of communication in the control of group coordination is provided by a finding in the life sciences that all species depending for survival on membership of a collaborative social group are characterised by an effective system of intra-group communication (e.g. Boinski and Garber, 2000; Pastor and Seeley, 2005; Tschinkel, 2006). For example, research on animal groups has revealed that coordination depends on effective inter-animal communication (P. Feltovich, personal communication; Smith, 1977). Animals exhibit behaviours that, like those of humans, allow or disallow other animals to collaborate. For example, animals have ways of displaying a readiness to interact, which includes kinds of chirping, various forms of bowing, "tidbitting", in which a morsel of food is offered, and touching. By contrast, absence of an opportunity to interact is indicated by various forms of sticking-out-the-tongue, displaying the tongue, chattering barks and vocalisations at special and unusual frequencies (Feltovich *et al.*, 2004).

In addition, a long-prevalent paradigm in animal studies is that communication, in the form of various signals, increases "the predictability of the individual

signaller's current and future behaviour", which, in turn, facilitates coordination within groups (Boinski, 2000: 422). For example, a challenge for species that depend on coordinated locomotion is reaching a group-level "plan" about when and where to travel. Research has shown that locomotion displays by certain members of the group provide this information in advance of the movement so that group members can anticipate and thus prepare for movement. For example, geese, which fly as a coordinated group, toss their heads before taking flight in order to indicate imminent flight (Smith, 1977). Furthermore, lead members of groups of primates that move in troops provide loud calls, such as "deep, hoarse, clucks", to indicate the imminence and intended direction of the movement (Boinski, 2000: 422). Similarly, honey bees engage in "buzz-runs", which involve runs through the most clustered part of the colony, as a signal to the colony that whole-colony travel is imminent (Dyer, 2000).

Other research on insects has provided examples of signalling used to coordinate the division of labour. Worker bees within honey bee colonies utilise at least four signals for coordinating food foraging and collection activities. These include the waggle dance, tremble dance, shaking signal and brief piping signal (Dyer, 2002; Pastor and Seeley, 2005; Schneider and Lewis, 2004). When a colony needs to gather nectar, forager bees that are successful in finding nectar use waggle dances to direct other, less-successful foragers to nectar sources. When a colony's rate of nectar collection exceeds its rate of nectar processing, successful foragers use tremble dances to signal to other bees that they should begin working to process nectar and to inhibit foragers from producing waggle dances. When a colony needs to activate foragers after a period of low foraging activity (e.g. due to bad weather), successful foragers shake to signal to other foragers that they should follow waggle dances. The use of the piping signal is less clear, but studies have provided evidence that it is used as a "stop signal" to stop other bees from waggle dancing (e.g. Pastor and Seeley, 2005).

With regard to human groups, I/O psychologists have asserted that members of effective groups use two key types of communication to exchange information allowing the creation and maintenance of a model of the current situation: intentional and unintentional communication (MacMillan *et al.*, 2004; see also Fisher and Hawes, 1971; Gouran and Hirokawa, 1983; Poole *et al.*, 1986). Intentional verbal communication involves speech between group members (e.g. "I'll be finished in five minutes"). Intentional non-verbal communication involves non-verbal signals between group members (e.g. holding up five fingers to indicate that a task will be finished in five minutes). Unintentional communication is communication that is unintentionally sent by one party to another. In group settings, unintentional communication is usually in a non-verbal form. One such form involves sensations of other group members' operations (e.g. I can see or hear what this group member is doing) or of the environmental affects of other group members' operations (e.g. the boxes are stacked and thus the group member responsible for packing them must have finished packing them; Eccles and Tenenbaum, 2004, 2007).

Direction

A final mechanism underlying the control of divided labour in groups is direction. As Hutchins asserted, "Mass labor must be coordinated and led" (1995a: 177). Such direction is usually provided by an individual or a few individuals within the group. These individuals are often deemed by the remainder of the group members as being in exclusive possession of some specific assets relevant to the directorial role that warrants these individuals being allocated this role. Typical examples of such assets include intellectual capabilities, as in the example of coaches in sport or a board of directors of a company, and specific skills in managing, leading and coordinating groups. One key function of such directors, even in highly democratic groups, is to use their authority to end debate about, and then make final decisions regarding, how labour will be divided and controlled within the group so that coordination can be achieved.

Summary of concepts

This section began with a description of how labour, and cognitive labour in particular, can be divided among group members so that groups can maximise the efficiency with which they undertake tasks involving demands that would overwhelm an individual. Following this, there was a discussion of how the social organisation of, and communication within, groups can affect the group's cognitive properties. Next, the challenges of achieving coordination amongst multiple group members and their operations were introduced. Lastly, the control mechanisms that can enable such coordination to be achieved, such as planning, communication and direction, were described.

A social-cognitive understanding of a sport organisation's preparation for competition

In this section, there is an attempt to illustrate the utility of a social-cognitive perspective by adopting this perspective within a case study of the functioning of a sport organisation. There is also an attempt to show how such a perspective provides insights that are complementary to, but that would not have been provided by, more traditional perspectives on group functioning. To our knowledge, such an interpretation in the field of sport psychology is without precedent and should promote further research in this area.

The organisation studied here is a national orienteering squad. This squad has been observed during studies of elite-level orienteering that have been undertaken by the first author and his colleagues over the last decade (Eccles, 2006, forthcoming; Eccles *et al.*, 2002a, 2002b, 2006, 2008). These observations were made during and following interviews, communications, and laboratory- and field-testing sessions with the squad's members, coaches and sport psychologist, and in particular during the first author's attendance at one squad training camp in 1998 that involved eating, sleeping, travelling and training alongside the squad.

Competition preparation in orienteering

Orienteering is an individual sport in which winning is achieved by being the fastest to navigate on foot through a set of points, known as controls, in a specific order over wild terrain. The distance from one control to the next is known as a leg. An orienteering course typically comprises 25 legs over 15 kilometres. Controls are symbolised by circles printed on a map. The map is presented only seconds before the race begins and is carried with a compass during the race. Given the time constraint inherent in the sport, orienteers will typically run during the race as fast as possible given the distance.

Typically, elite orienteers attempt to peak at only a small number of major competitions each year, such as the World Championships. Eccles *et al.* (forthcoming) identified that elite orienteers prepare in different ways for each major competition because the task constraints (Newell, 1986; Vicente, 2000) inherent within a competition change between competitions. While Eccles *et al.* (forthcoming) described changes to various sets of task constraints across competitions, for brevity the focus here is on only one such set, which is that relating to the competition's terrain. To elaborate, as each major orienteering competition is held in a different country each year, the terrain can vary dramatically between competitions. The terrain can be considered to constitute a set of task constraints because it determines, in large part, the navigation and running-related demands of the competition (Eccles *et al.*, 2002a). For a simplified example, orienteering in hilly compared to flat terrain places different physical demands on the orienteer. Additionally, navigating in forest-covered sand dunes versus on treeless moors places very different navigational demands on the orienteer.

Because the constraints associated with the terrain change with each competition, at least at a specific level, it is imperative that orienteering squads identify the constraints unique to an upcoming competition, termed *competition constraints*, and subsequently use them to identify and design practice environments that represent those constraints as closely as possible (Araujo *et al.*, 2004). Consequently, prior to competition, squad members may better achieve "maximal adaptation to task constraints" (Ericsson and Lehman, 1996: 273; Vicente, 2000). The identification of the constraints unique to an upcoming competition becomes a task in itself, and one that must be undertaken before the competition and with enough time that representative practice environments can be identified, designed and utilised. However, the identification task has its own constraints. The competition organisers prohibit access to the actual site of the competition for up to two years prior to the competition to prevent orienteers living local to the competition site gaining an unfair advantage. Thus, direct identification of the competition constraints is made impossible.

However, the national orienteering squad observed by the first author used various strategies to help identify competition constraints without violating the access rule. The primary strategies are described as follows. To provide some context within which to interpret the strategies, the organisation of the squad involved a head coach, two assistant coaches, a doctor, a sport psychologist, a

variety of volunteer organisers who were often parents of squad members, and approximately ten male and ten female squad members. One raw representative quotation from studies by Eccles *et al.* (2002a, forthcoming) is used to describe each strategy.

Sharing of existing knowledge of terrain

When the location for a major upcoming competition is first announced by the competition organisers, squad coaches ask all members of the squad to share with the remaining members any knowledge they may have about the terrain at the competition location and about other similar terrain from which inferences about the competition terrain can be made. Squad members usually have experience orienteering in a wide variety of terrain in many different countries. Consequently, they may have acquired knowledge about the terrain at the competition location having previously orienteered within similar terrain located in the region or country of the upcoming competition. Also, squad members have often acquired knowledge during their orienteering careers about the terrain at the competition location from various narrative sources (see Bal, 1997) such as stories, anecdotes and accounts of orienteering from other orienteers and coaches (e.g. "The terrain is always very technical in Sweden"). Consider the following example of an orienteer's acquired knowledge of terrain in southern Norway:

> Most of my orienteering abroad last year was done in southern Norway .... You [are] moving through the terrain so slowly ... it seems to make you want to ... need more detail as you're going along the leg .... It's just fairly low visibility and there's very little in the way of man-made line features so you're always having to read the ... detail and having to stay in contact with the map a lot more of the time .... You're looking at it all the time .... It becomes much more than simply checking off the big features because all the features look the same ... you need to be checking for shapes, getting down to much more detail.
>
> (Male orienteer)

Utilising externally located information

Squad coaches also ask squad members to make use of *locations* (Wegner, 1986) external to the squad known to contain or have the potential to contain information about the competition terrain or terrain similar to the competition terrain. One key type of location involves materials such as topographical maps, specialist orienteering maps and aerial photographs. Orienteers often assemble collections of such materials over their orienteering careers for a variety of purposes. The squad members search any collections they may have for these materials and share their findings with the remainder of the squad.

Another key type of location concerns *contacts* external to the squad, such as coaches and other orienteers. Often, squad members have acquired many such

contacts over their orienteering careers and inquire of these contacts whether they have experience of, and thus knowledge about, terrain similar to the competition terrain. Squad members then share any obtained information with the remainder of the squad.

Squad members also utilise higher-order locations, which are locations that contain or have the potential to contain information about other locations. For example, members will ask their contacts whether they have any relevant materials that could be provided to the squad or know any other contacts with relevant knowledge. Members will also use the Internet to search for websites that might contain relevant materials. An example is a land survey company website containing aerial photographs from a recent survey of relevant terrain. The following orienteer provides evidence of such processes: "I knew a few people from other countries going who I'd met up with in competitions in Sweden ... and they told me about what they expected ... [and] about maps that were relevant [to the competition terrain]" (male orienteer).

Travelling scout groups

A third strategy involves small subsets of the squad, termed here *scout groups*, travelling to the host country at various times throughout the year preceding the competition. Each scout group's task is to gather information about the competition terrain. This is undertaken by first identifying areas of terrain similar to the competition terrain and then, where possible, orienteering within these areas to better understand the competition constraints. The groups also take video recordings and photographs of the terrain. While there, the groups often also meet with local orienteers who function as information locations by imparting to the squad members relevant knowledge they possess about areas of similar terrain and lending the members materials, such as maps. Upon their return home, the scout groups share their gathered information with the remainder of the squad. This process is described in the following quote:

> The orienteers [acting as scouts] came back from Japan and said, "The ground coverage is mostly bamboo grass and it tramples very easily and makes paths, and the ground is steep and quite sandy, which is good for 'contouring in' and, you know, all of that information is passed on [to the remainder of the squad]."
>
> (Male coach)

Identifying representative local terrain

Once some of the uncertainty about the competition constraints has been reduced, squad coaches ask squad members to consider areas of terrain that are representative of the competition terrain but located nearer to the squad's region or country. Because these areas involve constraints representative of those at the competition, they constitute "ready-made" practice environments.

The same processes involved in identifying the competition constraints are used in identifying representative local terrain.

First, individual squad members are asked to share any existing knowledge they may possess about such areas. Squad members come from different regions within the squad's own country, and each member possesses a good knowledge of the terrain in his or her home region that can be used to identify representative terrain. Second, the squad makes use of external locations (i.e. materials and contacts) to help identify areas of representative local terrain. Third, when potential areas have been identified, coaches ask squad members with homes in the regions containing those areas or who are involved in upcoming competitions in those regions to visit the areas and evaluate their potential as practice venues. When areas of terrain have been identified as useful for practice, the squad coaches organise training camps for the squad within those areas. This process is described in the following quote:

> And we'll obviously look at everything when we're over there [in Japan] and spend lots of hours in the terrain over there. But then, once we get back here, well, we have been trying to find similar areas in Europe .... And there's not many but you can find a few that are technically [i.e. navigationally] similar or physically similar. On the physical side, Japan is very hilly and extremely steep and there's lots of ups and downs. We've been looking for areas like that. On the technical side, it's quite tricky finding the best route. It's quite difficult – we can't find areas with compact valley systems which Japan has and where the routes are almost the same. We just pool our memories together and ... there was an area in Scotland someone came up with. Someone else also said, "Oh, there's tons of terrain like that in Lithuania." So we're having a team selection right now in Lithuania.
>
> (Male orienteer)

Division of information-gathering labour

While the labour involved in gathering information about the competition constraints and, subsequently, identifying representative local terrain was divided among the group's members, it is typical that this division is not equal in quantitative or qualitative terms. The cause of this inequality involves differences on a variety of dimensions among the individual squad members. These dimensions include available resources such as time and finances, specialist knowledge of information about the competition constraints and the locations of areas of representative local terrain, and motivation. Thus, some squad members are allocated tasks requiring considerable time and money, such as travelling to the host country, because they have the fewest constraints on these resources (e.g. some members were university students with long holidays). In addition, some squad members undertake exclusive tasks owing, for example, to their unique knowledge. To elaborate, some members possess unique knowledge of contacts and thus contact them for relevant information. By contrast, other members

with no such knowledge possess exclusive knowledge of representative local terrain and visit them to evaluate their potential as practice venues.

Communication of information

Group members share existing knowledge and, as they become available, share information and materials relating to the competition constraints with other squad members using a variety of communication mechanisms including: (a) face-to-face interaction at squad training camps and, for subsets of the squad, at local orienteering club meetings; (b) telephone calls; (c) email; and (d) various other electronic media such as web forums. Given the number of squad members and communication mechanisms, the communication flow among the group members is complex and frequent. Two communication mechanisms in particular appear noteworthy for their utility. The first is face-to-face interaction at the squad training camps. Coaches set up a series of these camps for all squad members at various locations around the squad's own country in the months preceding a major competition. There are several advantages of face-to-face interaction at these camps compared to the other communication mechanisms used by the squad. First, the camps allow squad members to easily share information via a variety of media including verbal accounts, photographs, maps and video. Additionally, squad members juxtapose these media and thus easily compare and contrast the information they provide. Second, communication at the camps is synchronous rather than asynchronous, which means that members receiving information are able to quickly and easily seek clarification or ask for elaboration about some item of information from the member providing that information and receive a response with no delay (Fiore *et al.*, 2003). Finally, many squad members are involved simultaneously in the discussion of a given item of information, which is useful given the diversity of knowledge afforded by a large group (as discussed above, pp. 302–303).

The second communication mechanism noteworthy for its utility is email. Squad members use email to send messages and materials such as photographs and maps to all the members and thus new information, almost regardless of the sender's location, is disseminated easily. For example, the scout groups, while travelling, send reports by email about the terrain they are exploring back to the squad members in the squad's home country.

Control and direction

The control of the division of labour within the squad is achieved in part by direction. Direction is provided by the coaches and its effectiveness is facilitated by their possession of authority. Authority is assigned to the coaches through a variety of mechanisms including: (a) the social convention that "appointed coaches are the squad leaders"; (b) respect of the coaches' experience and knowledge, and for their effort and motivation towards enhancing the squad's performance; and (c) an understanding of their power to select the squad

members who will represent their country at major competitions. The coaches play a key role in allocating the labour required to gather information about the competition constraints and allocating deadlines, or at least preferred deadlines, for the delivery of that information. Deadlines are often the dates of the squad training camps so that squad members can disseminate their gathered information to those attending the camps. In addition, the control of the division of labour is achieved in part through the group's self-organisation. When labour is being allocated, squad members often volunteer to undertake some specific form of labour, usually because they are aware of their possession of a specialisation or resources relating to undertaking that labour (as discussed above, pp. 302–303).

Extent of plan sharedness

A plan specifying the operations that are to be undertaken by each squad member is formulated predominantly by the squad coaches. Each squad member is only required to know what operations he or she should undertake and that the other operations important for the squad as a whole, such as travelling to the country hosting the competition, are going to be undertaken by other members of the squad. Thus, the only individuals with full knowledge of the plan are the coaches. The remaining squad members possess only part of this plan. This is because there are few instances in which group members must coordinate their operations while they are being undertaken.

By contrast, there is a need to coordinate the outcomes of these operations, in that certain operations have deadlines for their completion (as discussed above, this page). Thus, the requirement for, and extent of, plan sharedness in this instance does not extend fully to the nature of the operations but just to one temporal component of those operations, which is their completion date.

Interpretations from a social-cognitive perspective

From a social-cognitive perspective, a key finding relating to the functioning of the squad in preparation for major competitions is that, while orienteering is essentially an individual sport, there are clear advantages for the individual squad member and his or her preparation with regard to being a member of the squad described. The first advantage relates to the process of sharing existing knowledge about the competition terrain. The individual squad member has rapid access to information about the competition constraints that would otherwise require considerable time and effort to gather, and, perhaps for some information, be impossible to gather. Quantitatively, the individual squad member has the potential for access to over 20-times the knowledge relating to the competition constraints that he or she possesses individually due to the number of members comprising the squad. Qualitatively, the individual squad member has the potential for access to rich, elaborate and relatively exclusive knowledge relating to these constraints owing to the extensive experience of other squad members such as the coaches. Viewed in terms of transactive memory theory, the goal of the squad in

sharing the existing knowledge of each member is to move from a set of differentiated memories, in which each squad member holds different knowledge about the terrain, to a fully integrated memory system, in which each squad member holds the knowledge about the terrain derived from all of the remaining squad members (Wegner, 1986).

The second advantage relates to the division of labour in gathering information about the competition constraints. With each squad member actively gathering information, each individual member is potentially able to benefit from over 20-times the gathering labour compared to him or her working alone. If each squad member is able, on average, to obtain information from one external contact and access one material item such as a map, an individual squad member has potential access to over 40 sources of information about the competition constraints. The travelling scout groups exemplify the advantages of the division of labour. Those squad members who have fewest constraints on travel will tend to volunteer to travel to the country hosting the competition, gathering information that would otherwise be unavailable to the individual orienteer who was unable to undertake this travel.

Finally, the labour associated with controlling the division and coordination of the labour associated with gathering information about the competition constraints and identifying representative local terrain is undertaken largely by the coaches. The coaches also undertake most of the labour associated with organising squad meetings to help facilitate the sharing of gathered information, training within representative local terrain and travel arrangements for the scout groups. Thus, individual squad members are burdened minimally with the labour required to control the division of labour that affords them the cognitive advantages discussed above.

Thus, at least in this instance, membership of a social group that has a shared goal, in which labour is allocated on the basis of member expertise and resource availability, and in which this labour is directed and controlled so that its coordination is achieved, can convey clear cognitive advantages for the individual group member. Specifically, when compared to operating alone, an individual operating in a group of this nature can access task-relevant information of superior quantity and quality, more rapidly and with less effort.

Limitations of the presented case study

During an excellent review of this chapter, an anonymous reviewer proposed two related limitations of this case study. The first concern was that there is a noteworthy difference between the type of coordination featured within the case study – that is, the coordination of the orienteering squad's efforts to prepare for competition – and the type of coordination required for effective team performance in sports such as football and rugby union. We do not disagree. One important difference is temporal. Because the environment in which a sports team such as a football team operates is often unpredictable, externally paced and changes rapidly, sports teams must coordinate their actions very rapidly, which, among

other things, restricts use of intentional verbal communication as a means to achieve coordination (Eccles and Tenenbaum, 2004). By contrast, within the case study, there were few time constraints on the orienteering squad as it prepared for competition and thus intentional forms of communication were used extensively to coordinate the squad's work. However, while both the orienteering squad and dynamic sports teams differ in terms of the specific means by which coordination is achieved, both scenarios (a) involve a division of labour; (b) require coordination of that labour; and (c) use planning, sharedness, communication and direction to achieve such coordination. Thus, describing differences between the two scenarios in terms of the means by which coordination is achieved usefully captures more of the variance in the concept of coordination in sport but does not invalidate the collection of higher-order concepts proposed here as each concept within the collection generalises to, and hence is useful in understanding, both scenarios.

The second limitation raised concerned the use of the case study in demonstrating the potential of a social-cognitive perspective for enhancing understanding in the area of group functioning in sport. Specifically, it was proposed that the squad's preparation for competition is an activity that offers not nearly as interesting insights into coordination as a competition requiring dynamic coordination. Our concern with this argument is that it is "competition-centric". To elaborate, this argument largely ignores the extensive period of practice and preparation that precedes, and is the only means to achieving, competitive performance. In general, sport psychologists are as interested in practice and preparation for competition, given its importance, as with actual competitive performance. Furthermore, there have been recent calls for research on, and an increased interest in the impact of, organisational factors on a sport performer's psychological preparation for competition (Eccles and Tenenbaum, 2007; Hanton *et al.*, 2005; Pain and Harwood, 2007; Woodman and Hardy, 2001). Thus, we believe that introducing well-established concepts from social-cognitive psychology (e.g. transactive memory theory) to help explain how an organisation provides a cognitive advantage to its individual members prior to competition is unprecedented, timely and of utility to the sport psychology community.

Implications of a social-cognitive perspective on group functioning for athletes, sport psychologists and other practitioners

In this section, various implications of the social-cognitive concepts described in the present chapter for athletes, sport psychologists and other practitioners are proposed.

Unlock the group's cognitive potential

Coaches, managers and heads of sport organisations sometimes bring together the group members they train or oversee in an attempt to "tap their heads". For

example, they might ask leaders in the sport organisation to brainstorm about how to turn a period of low morale around in the organisation, ask coaches for their opinions about why there is poor cohesion in the team, or ask players to identify what strategies they think will work best against a difficult upcoming opponent. Given that research has shown that, in a group setting, information only available to one group member tends to be treated as mere opinion and thus is less likely to be discussed (Stasser and Titus, 1985), it is recommended that each group member is allowed a certain amount of uninterrupted time to present his or her ideas to the group (Adler and Rodman, 2002). This way, a key social process that would otherwise stifle the cognitive potential of the group will be ameliorated and the potential for otherwise hidden expertise and creative thinking within the group more effectively "unlocked".

Enhance plan communication

In situations where the group leader, such as a coach, constructs plans independently of all or even some of his or her group members, a key challenge becomes effectively communicating those plans to members of the group. Poor communication may mean that some members fail to comprehend plans and thus the desired shared state is not reached. Based on a review of research addressing coordination in living systems, Eccles and Groth (2006a) proposed three principles of communication for enhancing group communication. These are adapted here so that they pertain specifically to the communication of plans to group members.

First, messages about plans are more likely to be comprehended correctly if they are presented in *multiple sensory modes*. For example, in American football, the coach may demonstrate a play to an offensive team by asking the team to attend visually to a poster-sized schematic of the field layout and the intended player movements, while explaining the play verbally. Second, messages are more likely to be received if there are *redundant* communication mechanisms. With regard to a presentation of a schematic and a verbal explanation, the American-football coach may also show a video of the play being run by another team and provide a page-sized version of the play in the team's playbook. Multiple, redundant sources of information about a group's plans will make the group more robust in the face of perturbations. If a group member fails to listen correctly, shows up late when plans are explained or, in the case of the American football player, loses his or her playbook, additional sources of information about the plan are available (Hutchins, 1995a). Finally, plans are more likely to be understood if plan information is *enduring* rather than transient such that these sources of information are made as *continually available* as possible. This way relevant information can be accessed on demand, such as when certain aspects of the plan may become hard to recall owing to retroactive interference, say, from learning about other plans, or simply due to forgetting. The playbook is an example of an enduring source of information. By contrast, the coach's verbal explanation of the plan is a transient source of information. However, in the

same a way that business employees might use a mini-tape-recorder to document the proceedings of an important meeting with their co-workers, an athlete could use a recorder to document the coach's verbal explanation of a plan to provide a more enduring source of plan information.

Use "check-backs"

Since it is possible for group members to erroneously believe that each member shares the group's plans, such as game plans, it might be beneficial to develop methods of checking whether group members understand the group's plans and their role in these plans. In team sports, coaches might (a) encourage team members to come forward with queries about plans while they are being developed; (b) provide structured "IDU" opportunities for team members to say "I don't understand" privately to a coach in order to avoid social pressures "not to look foolish" in front of the team; and (c) develop a routine of checking back with each team member that the member fully understands the plans. A coach can operationalise this last strategy by asking a team member to provide a verbal report of his or her understanding of the team's plan. Check-backs are used in the military where it is critical that plans are correctly shared, and have been referred to in the I/O literature as a form of closed-loop communication (McIntyre and Salas, 1995; McIntyre *et al.*, 1988; Porter *et al.*, 2003).

In addition, check-backs also increase members' accountability because once a player has shown the coach that he or she understands the plan through the use of a check-back, the player knows that a failure to undertake his or her part in the plan cannot be blamed on a failure to understand the plan. Within sport psychology, research has highlighted the importance of role clarity and acceptance by members of groups, albeit for social rather than cognitive reasons (e.g. Bray *et al.*, 2005). Nonetheless, as Eccles and Tenenbaum (2005) asserted, in football the strategies outlined above might be beneficial in helping players better understand their role on the team.

Enhance group member communication

As group communication appears to be a key mechanism by which group members' situation models can be created and maintained, enhancing communication among group members should facilitate coordination. There is some existing research indicating that members of expert teams develop shared knowledge of a highly specific code used for communication. Such development is reflected by succinct, domain-specific and standardised messages (Bastien and Hostager, 1988; Kanki *et al.*, 1989; Smith-Jentsch *et al.*, 1998). This reduces communication costs in various ways, such as by increasing the quality and quantity of information transferred in a discrete communication and increasing the accuracy and reliability of message interpretation. For example, Bastien and Hostager reported that what appeared to be spontaneous jamming in jazz bands was actually concurrently coordinated through band members' communication

in the form of intentional verbal and non-verbal codes that "have become a tradition in the profession" (1988: 588). These codes could be interpreted by other band members owing to the band having achieved a shared knowledge of them. An example of the non-verbal codes included turning to an individual, making eye contact at particular points in the performance, and changing the volume of one's playing. These codes allowed the musicians to communicate so that in-process coordination could be achieved but remained relatively undetectable by the viewing and listening audience.

Kanki *et al.* (1991), through the use of aircraft simulators, studied the communication patterns of 18 aircrews that had different error-rates during landings. Crew communications were coded into categories such as commands, questions, observations, replies and acknowledgements. The frequencies of utterance dyads, defined as an initiating utterance followed by a response utterance, were then computed. One variable of interest in the study was communications variation, defined as the degree to which a given crew varied from the overall expected frequencies generated from an analysis of all crews' communications. The communication variations of low-error crews were low when compared to those of high-error crews, suggesting that a standard and specific communication code had been adopted by the low-error crews resulting in higher group performance. Kanki *et al.* (1991) proposed that, by adopting such a code, the within-crew communications became more efficient, which aided coordination and, in turn, performance.

Thus, one method of enhancing group-members' ability to maintain their situation models is to establish a shared language within the group. The language should contain code words that are short, not easily confused with other code words and convey specific information so that group members understand exactly what message is being transferred. The code words can be in both verbal (shouts) and non-verbal (gestures) forms, and can also be encrypted. Message senders can also better signal which group member is the intended recipient by having the team develop succinct nicknames. These can also be encrypted in an effort to minimise the opposing team's ability to intercept the message and to know to whom the message is being sent.

Use cross-training

Industrial and organisational researchers have advocated cross-training as a means of enhancing group coordination and overall productivity (e.g. Ebeling and Lee, 1994; Hopp and van Oyen, 2004). This involves an individual group member spending time performing the role usually occupied by another member with whom there is a coordination link. One function of cross-training is that group members gain a better appreciation of the nature of the operations, both cognitively and behaviourally, undertaken by those with whom they interact, which, in turn, allows them to adapt their own operations so that coordination among the interacting group members can be enhanced. Another function is that group members can more flexibly take up other members' work when they

are overloaded. For example, if a quarterback in American football has received good training in blocking and tackling, he or she is better able to make crucial blocks or tackles that might be missed by overloaded offensive-line members and thus allow a thrown-to receiver to gain more territory.

Future research

Future research in this area might benefit initially from adopting a "work-backward" approach. To elaborate, studies might be focused first on identifying groups that can demonstrate reliably superior performance. The group-level mechanisms responsible for the division and coordination of labour within these groups could then be examined (Ericsson and Smith, 1991). For example, studies might be focused on the communication profiles of high- versus low-performing groups in sport. Following the method utilised by Kanki *et al.*, group-member communications in groups exhibiting different levels of performance could be captured by videotape during a game and coded into categories such as commands, questions, observations, replies and acknowledgements (see also Bowers *et al.*, 1998; Lausie *et al.*, forthcoming). The frequencies of the various combinations of utterance dyads could then be computed and the communication characteristics of the teams compared. When insights into the mechanisms responsible for the division and coordination of labour within superior-performing groups have been obtained, a work-forward research approach could then be adopted. To elaborate, interventions that are based on these insights could be designed and their efficacy for enhancing coordination, and ultimately performance in groups, tested via traditional experimental protocols.

Summary and conclusion

In this chapter, it was proposed that an understanding of group functioning in sport will be enhanced if the topic is studied from a social-cognitive perspective. Furthermore, it was suggested that sport psychologists might begin to move beyond examining (a) group functioning in sport from a social perspective; and (b) cognitive aspects of sport performance from an individual perspective, to considering a perspective that involves both social and cognitive concepts and in particular their interaction. The chapter began with a discussion of the contributions and limitations of the extant research on group functioning in sport. It was followed by an overview of key concepts relating to a social-cognitive perspective on group functioning that have the potential to enhance the current understanding of group functioning in sport. Next, there was an attempt to interpret the functioning of a real-world sport organisation, which involved an orienteering squad preparing for major competition using the described concepts. Finally, implications of a social-cognitive perspective for best practice were proposed and future research directions related to this perspective suggested.

To conclude, if sport psychologists are prepared to let the social and cognitive merge, there is the potential for a substantial extension of what is currently

known about group functioning in sport. To return to the example of the England rugby union team's winning drop goal in the 2003 World Cup final, adopting this new perspective may enhance our understanding of how a team of 15 players handling a small, oddly shaped leather ball can operate "like clockwork".

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