DO ANALOGIES IMPROVE THE RECALL OF TACTICAL INFORMATION UNDER MATCH CONDITIONS?
BY
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Rugby Union requires a range of physical and cognitive skills, one of which is the understanding and execution of messages sent onto the pitch by the coaches. Anyone who has ever sent, received or carried a message onto the field of play during a match will know that if it was as simple as sending on a set of instructions telling the players what to do then it wouldn't be the constant source of frustration that it so frequently is. This is in part due to changes that have occurred in the game since turning professional, redundant messages and also a failure to appreciate exactly what it is the players have to achieve under what many seem to forget are challenging circumstances. For my M.Sc. research project in Applied Sports Science, I compared different methods of learning for tactical information that could potentially form a component within a superiorly structured process for learning and communication during training and matches. Before discussing the experiment, let's consider what is actually happening.

Rugby Union has become increasingly structured in both attack and defence (Eaves & Hughes, 2003; Duthie *et al*., 2005) and has adopted the same strategy as many other sports in utilising patterns of moves to force opposition mistakes and score points. Success or failure relies not only on the successful execution of these patterns, but also on the successful matching of attacking patterns to opposition defensive patterns and vice versa (Dallaglio & Jones, 1998). In either situation, the coaches may want to alter, emphasize or remediate their team's pattern of play in order to change the 'shape' of the game. During breaks in play, tactical and technical messages are regularly carried onto the pitch by water carriers and members of the medical team. Messages are most often in the form of an explicit set of instructions and must be understood before being actioned or passed on to team members. Although seemingly straightforward, consideration of the process and the resources required highlight how challenging it actually is.

Any message relayed to the players must be attended to, processed then acted on. Critical to this process is the application of attention (Abernethy, 1993) as it provides the link between information processing and action (Moran, 1996). It is believed that attention is a finite resource that is allocated strategically (Kahneman, 1973) and is responsible for three functions (Moran, 1996):

- What we pay attention to.
- How attention is distributed between concurrent tasks.
- The maintenance of alertness.

The role of attention is to allocate ‘processing’ resources between the three functions to the tasks of highest priority (Moran, 1996). Given that resources are limited, allocating attention to one task will result in an improved performance in that task with a decrement in performance of any concurrent tasks (Kahneman, 1973). As attention requires mental effort, it will induce fatigue and reduce the amount of processing power available for deployment (Kahnemann, 1973; Job & Dalziel, 2001). In demanding situations, such as sporting competition, changes in allocation of attentional resources may only result in the maintenance of performance in the primary task and a reduction in performance of any secondary tasks (Moran, 1996). The volume of available resources is dependent on arousal (Kahneman, 1973) and exercise is believed to affect cognitive functioning as an inverted-U (Tomporowski & Ellis, 1986), with performance being dependent upon the duration, intensity, nature of the fatigue and task to be performed (Brisswalter *et al.*, 2002). As Rugby Union is a team sport characterised by its highly physical intermittent nature (Deutsch *et al.*, 1998; Duthie *et al.*, 2003; Duthie *et al.*, 2005), with players involved in a range of activities as physiologically diverse as walking, sprinting, mauling and tackling (Deutsch *et al.*, 1998), it can be seen how Rugby Union requires not only a high degree of physical performance and motor skill, but also a high level of cognitive functioning (Burke, 1997). Therefore, communicating with players is not going to be as straightforward as just sending on a message.

Having allocated attentional resources to the message in the face of fatigue and variations in arousal, players must attempt to make a link between it and what they have learnt or know. Knowledge is broadly categorised as existing either implicitly or explicitly. Implicit knowledge is knowledge that can not be consciously retrieved or declared explicitly (Moran, 2003). Of more importance are the characteristics associated with this knowledge (Reber, 1993). They are:

- Robustness.
- Age and IQ independence.
- Little variability.

These characteristics potentially make the use of implicit knowledge in Rugby Union highly beneficial. For example, the age independence of implicit knowledge lends itself to the constantly evolving moves and patterns used through a competitive season. The robustness and lack of variability should theoretically enhance the speed and accuracy of recall under pressure. It is this automaticity of thought and resulting reduced requirement for processing that is most desirable, given automatic processes are involuntary, easy, consume relatively little mental capacity, can be carried out concurrently (Haberlant, 1994) and are affected less by fatigue (Moran, 1996). Given these qualities and the potential benefits, it could be assumed that sports coaches would look favourably on teaching methods that bring about more accurate robust responses under time pressure, particularly given the stressful nature of sporting competition (Liao & Masters, 2001). Implicit knowledge would appear to provide a mechanism that can assist with the problems of attending to and acting on messages and enhance players' ability to communicate during the limited time available. This could benefit the team from both an organisational and tactical perspective and should, theoretically, become more marked as the game progresses.

Analogies are frequently used in education and sport to provide a verbal representation of the task to be executed (Liao & Masters, 2001). They don't rely on verbal information or rules, suggesting they may invoke mechanisms akin to implicit learning (Liao & Masters, 2001; Poolton *et al*, 2006). Recent research has highlighted how the qualities of implicit learning can be mimicked using analogies (Liao & Masters 2001; Poolton *et al.*, 2006; Mullen *et al.*, 2007) and have examined discreet motor patterns such as putting in golf, (Masters, 1992: Bright & Freedman, 1998; Mullen, Hardy & Oldman, 2007) and topspin forehand in table tennis, (Liao & Masters, 2001: Poolton *et al*., 2006). Although not providing an absolute improvement in performance (Mullen *et al*., 2007), analogy learning consistently outperforms explicit instruction under the applied stress of perceived pressure, prize money (Mullen *et al*., 2007), complex decision-making (Poolton *et al*., 2006) and ego-threatening comments (Liao & Masters, 2001). No studies have been carried out for learning tactical information utilising analogies, and no study has used a game-type situation as the stress.

The aim of this study was to determine the effectiveness of analogies as a learning mechanism for the recall of Rugby Union attacking patterns, with a view to improving the process of on-field communication. The research project aimed to prove three hypotheses.

1. Relative to explicit learning, analogy learning will facilitate significantly improved speed of pattern recall.
2. Relative to explicit learning, analogy learning will facilitate significantly improved accuracy of pattern recall.
3. Analogy learning will result in significantly fewer explicit statements than explicit learning.

Participants & Procedure
Eleven members of the London Irish academy (U20) took part in testing. The group was comprised of five forwards and six backs. Their age, height, body mass and resting heart rate were 19·0±0·6 yrs, 185·4±8·5 cm, 94·5± 11.3 kg and 64·4 ± 12·2 $b.min^{-1}$ respectively (mean ± *s*). The players were split into two groups; one learned six patterns conventionally, the other group using analogies. They were required to recall and draw four playing patterns on a white board at four different time points, separated by three bouts of high intensity intermittent cycling. The testing procedure is outlined in figure 1. The patterns used were not representative of any already known to the participants and subjects were only asked to recall the same four patterns in different orders at every testing point. This allowed for increased sensitivity of scoring and direct comparison between groups and testing points, preventing any one pattern skewing the results.

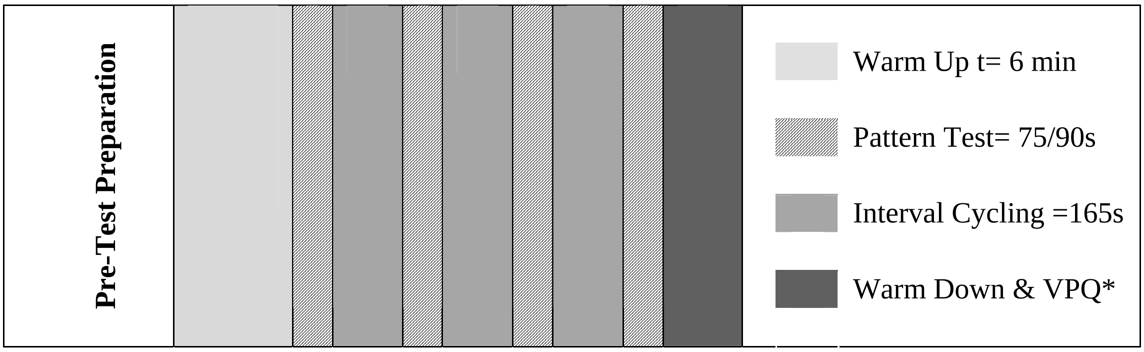

Figure 1 Study Protocol (*Verbal Protocol Questionnaire)

Following the warm down and before leaving the laboratory, subjects were provided with the verbal protocol questionnaire for completion to test the hypotheses that the analogy group would retain less explicit knowledge. The use of analogies will have mimicked the qualities of implicit learning if there is an absence of explicit knowledge (Reber, 1993). All participants were asked to write down any knowledge they had retained specific to the patterns.

Discussion

It had been hypothesised that both the speed and accuracy of response for the analogy group would be superior to that of the explicit group. Both visually and descriptively, this was the case (Figure 7.). However, from a statistical perspective the only significant difference was in the rate of learning exhibited by the analogy group (Figure 7.). This is visually expressed by the gradient of the analogy line from the initial test to the 2nd and 3rd tests for speed.

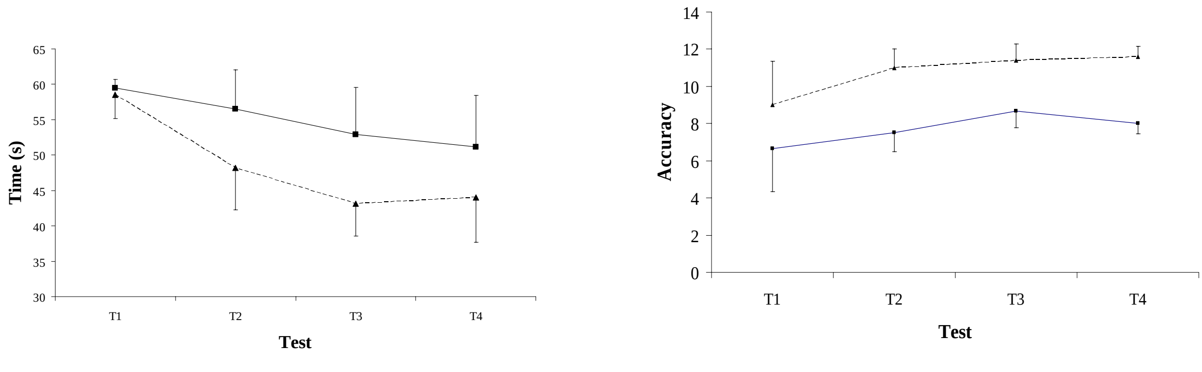

Figure 7. Mean Speed & Accuracy of Response

This result supports the age-independent quality of implicit knowledge (Reber, 1993) and it makes sense that pictures are learned faster than words, given that knowledge is thought to be symbolically represented in our memory (Moran, 1996). No significant difference was found for rate of learning in the research on motor skills (Masters, 1992; Bright & Freedman, 1998; Liao & Masters, 2001; Poolton *et al.*, 2006; Mullen *et al.*, 2007). Key in comparing this study to motor skills research is the very different nature of the tasks and how they were learned. Here, all subjects had thirty minutes to learn six patterns before being tested, as opposed to learning a single motor skill and repeatedly practising that skill (Masters, 1992; Bright & Freedman, 1998, Liao & Masters 2001; Poolton *et al.*, 2006; Mullen *et al.*, 2007). The results do not support the hypothesized benefit of significantly faster responses for the analogy group. However, this may have been down to the study design as apposed to the underlying theory. Regardless of this, rate of learning is a desirable characteristic in an environment where athletes have a lot to learn in short periods of time and, although not significant, the mean difference between the groups for speed of 6.57± 0.1s could be sufficient to be of importance during a match. For accuracy, only a significant difference for main effect was found; however, the results were approaching the limit for an interaction effect. As with the speed, this may be down to design of the study as apposed to the underlying theory for using it. The mean difference between groups was 3.04 ± 3.4 pts and it is not clear exactly how this improvement, even if it were significant, would carry over into a game context given the need not to draw messages but to communicate and act on them.

Results for accuracy of response fail to support the hypothesis that the use of analogies would provide robust knowledge lacking in variability, indicative of implicit knowledge (Liao & Masters, 2007). The lack of significance between the groups on outright performance is supported by the literature on motor skills (Bright & Freedman, 1998, McMoris *et al*., 1999, Liao & Masters 2001, Mullen *et al.*, 2007), and it is only when a further stress such as a secondary tasks (Liao & Masters, 2001) or external stress (Mullen *et al.*, 2007) is applied that the analogy group outperforms the explicit group. This decrease in the explicit group's performance arises from division of attentional resources (Moran, 1996) as opposed to any outright improvement by the analogy group. In this study, the stress was the match-type conditions of a time restriction, combined with the physical exertion of the interval cycling.

Heart rate was taken as a performance measure and there was no interaction effect and, most importantly, no main effect between groups, ensuring that any between group performance differences were not as a result of the interval cycling.

	S_1	S_2	S_3	S_4	S_5	$\mathbf{S_6}$
Explicit	6.2 ± 1.6	6.2 ± 1.8	5.7 ± 1.8	5.5 ± 2.2	6.2 ± 1.6	6.3 ± 2.5
Analogy	4.4 ± 1.7	5.2 ± 1.3	3.8 ± 0.4	4.8 ± 0.8	4.3 ± 1.4	4.6 ± 2.6
P	0.78	0.423	0.051	0.098	0.239	0.962

Table 2. Mean number of statements for individual patterns

The most critical factor in explaining why neither of the performance measures resulted in significant results between the groups is the non-significance for the verbal protocol questionnaire. It was hypothesized that analogy learning would lead to knowledge that would mimic the benefits of implicit knowledge (Liao & Masters 2001). Implicit knowledge is differentiated from explicit knowledge by the number of facts and rules which can be articulated (Masters, 1992). The analogy group did articulate fewer statements but it was not significant. It would appear, therefore, that the rationale behind using the analogies is correct; however, their performance is very much dependent on the strength of the analogies used. This is further highlighted by the individual analysis of each pattern (Table 2) with S_3 being exceptionally close to significance. Added to, this S_5 was considered too weak to be one of the four pattern for testing, yet to the subjects it was the third strongest of the analogies.

As already discussed, the failure of the verbal protocol questionnaire to reach significance was critical and this raises issues regarding the limitations of how the information was named and presented to the subjects. Not all the analogies held equal meaning for the subjects, due to the associations between the patterns and their titles being created by the author. It does not, therefore, follow that the subjects would have the same strength of association. This is highlighted by S_5 being excluded despite being the third strongest analogy. Also, the manner in which the explicit group was presented with the information must be considered. For example, Mullen *et al.* (2007) and Masters (1992) both presented a list of instructions as presented in a golf manual. Here the explicit group were presented with a list of instructions alongside the graphical representation of the pattern to allow them to understand what the statements meant, allowing the explicit group not to learn the patterns explicitly at all, instead utilising their own analogies. One subject commented about the task, “It was easy once I stopped learning it how you’d asked. One of them had lots of kicking, so I remembered it as a Wilco,” therefore reducing the ‘explicitness’ of their knowledge. From an observational perspective, the two groups drew in completely different manners with the explicit group drawing the patterns exactly as they were ordered in their instructions and as they would be executed in a game. Also, the top score out of all subjects was achieved by an individual in the analogy group, who described himself as “heavily dyslexic” and commented, “It’s pretty much how I learn things anyway.” This might indicate how effective the matching of teaching method and learning modality could be for all players (Fleming *et al.*, 2005).

Effective instruction is an important component of optimal performance (Hodges & Frank, 2002) and this project highlights the difficulties in doing this during a match, a fact that should be considered by coaches before sending messages onto the pitch. The results from this study suggest it could be a powerful tool and merits further research, with attention being paid to the manner in which information is presented. Successful instruction is dependent not only on the clarity of the messages but also on the circumstances under which an individual receives them (Moran, 2004). It is the coach’s responsibility to teach the athlete what to do, how to do it and, hopefully, how to do it well (Hodges & Franks, 2003), and with the increasing volume of information being fed to players, along with the increasing physical demands of the game, it would make sense that tools such as analogy learning are used for tactical information within a framework for effective communication and teaching.