The role of the Perceptual Cycle in teams

Katherine L. PLANT*, Neville A. STANTON* & Catherine HARVEY*

*Transportation Research Group, Faculty of Engineering and Environment, University of Southampton, Southampton, SO17 1BJ, UK

ABSTRACT

Introduction: The Perceptual Cycle Model has been previously applied to help explain decision making, but this has only been from the perspective of one individual and not a team. This paper explores the team perceptual cycle process. Method: Four crew members from a helicopter team were interviewed about an incident using the critical decision method. Deductive thematic analysis was employed to analyse the transcripts. Results and discussion: The data were modelled into a team perceptual cycle to demonstrate how individual perceptual cycles contribute to the overall team process. The intentions of future work are discussed.

KEYWORDS

Theory and modelling; decision making; transportation (aviation); Perceptual Cycle Model

INTRODUCTION

The Perceptual Cycle Model (PCM; Neisser, 1976) is based upon the idea of a reciprocal, cyclical relationship between operator and environment. The PCM models interaction between person and world, with heavy emphasis on the role of schemata (knowledge structures based on similar past experiences). Neisser presented the view that human thought is closely coupled with a person’s interaction in the world, both informing each other in a reciprocal, cyclical relationship. Existing knowledge (schemata) leads to the anticipation of certain types of information (top-down processing); this then directs behaviour (action) to seek out certain types of information and provides a way of interpreting that information (bottom-up processing). The environmental experience (world) can result in the modification and updating of cognitive schemata and this in turn influences further interaction with the environment.

Recent research has applied the PCM to a variety of incidents which involved a high decision making component, including the Ladbroke Grove rail crash (Stanton and Walker, 2011), the Stockwell shooting (Jenkins et al., 2011) and the Kegworth plane crash (Plant and Stanton, 2012). The model only provides a representation of information processing for one individual. Contemporary perspectives on decision making acknowledges the importance of distributed decision making, i.e. multiple individuals and technological agents working together to make decisions (Stanton and Bessel, in press). The PCM has been used to underpin theories of team-processes. For example, the theory of Distributed Situation Awareness uses the PCM to explain why teams achieve compatible, rather than shared, situation awareness (SA; Salmon et al., 2009). The PCM emphasises the role of schemata in perception and decision making; Schema Theory argues that no two individuals will ever possess exactly the same schema because they will have had slightly different experiences, therefore team SA will only ever be compatible and not shared.

Despite the fact that the PCM has been used in decision making research, where team decision making is increasingly becoming the focus of research, there is little research that explores the perceptual cycle of a team. The PCM has been used to underpin theories of team-processes. For example, the theory of Distributed Situation Awareness uses the PCM to explain why teams achieve compatible, rather than shared, situation awareness (SA; Salmon et al., 2009). The PCM emphasises the role of schemata in perception and decision making; Schema Theory argues that no two individuals will ever possess exactly the same schema because they will have had slightly different experiences, therefore team SA will only ever be compatible and not shared.

Despite the fact that the PCM has been used in decision making research, where team decision making is increasingly becoming the focus of research, there is little research that explores the perceptual cycle of a team. This paper presents a case study of a Search and Rescue (SAR) helicopter team when dealing with a critical incident to explore a team perceptual cycle. The four crew members who were present in the helicopter: pilot flying (PF), pilot not flying (PNF), winch operator (WO) and winch man (WM), provided accounts of the incident. The data was qualitatively analysed using a coding scheme developed from the PCM. The resulting data has been modelled into a team-PCM to demonstrate how the world information, schemata held and actions performed for each individual team member amalgamate to form an overall perceptual cycle for the whole team. At this exploratory stage future research is also discussed.

METHOD

Critical decision method

The CDM (Klein et al., 1989) elicits decision making data through the use of cognitive probes as a tool for reflecting on strategies and reasons for decisions. The method was originally designed to understand decisions during non-routine incidents. Usually the CDM consists of four phases: incident identification, timeline construction, deepening probes and ‘what if’ queries. In this study, phase four was omitted, Klein and Armstrong


ISBN 979-10-92329-00-1
have acknowledged that it is acceptable to adapt the method to suit the needs of individual research projects. The cognitive probes were used to collect decision making information when the crew of a SAR team had to deal with a fault with the engine oil temperature (EOT) during a training exercise. A selected example of the probes are provided in Table 1. Interested readers are directed to additional texts for the full CDM procedure (e.g. Crandall et al., 2006; Klein and Armstrong, 2005).

<table>
<thead>
<tr>
<th>Area</th>
<th>Probe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goals</td>
<td>What was your specific goal during the scenario?</td>
</tr>
<tr>
<td>Decisions</td>
<td>What was the primary decision that you made?</td>
</tr>
<tr>
<td></td>
<td>What features were you looking for when formulating your decision?</td>
</tr>
<tr>
<td>Information</td>
<td>What information did you use to make that decision?</td>
</tr>
<tr>
<td></td>
<td>Was there additional information that you might have liked to assist your decision making?</td>
</tr>
<tr>
<td>Experience</td>
<td>Was the decision made comfortably within your experience (why/why not?)</td>
</tr>
<tr>
<td></td>
<td>Did your experience influence the decision that you made?</td>
</tr>
<tr>
<td>Expectations</td>
<td>Did you hold any expectations that influenced the decision making process?</td>
</tr>
<tr>
<td>Options</td>
<td>What other courses of action were considered/available to you?</td>
</tr>
<tr>
<td></td>
<td>How was one option chosen and the others rejected?</td>
</tr>
</tbody>
</table>

Participants
All four crew members were male. The PF was 48 years old with 5500 hours of experience (600 on type). The PNF was 55 years old with 9000 flying hours experience (1500 on type). The WO was 65 years old with 6000 hours of relevant experience (500 on type) and the WM was 60 years old with 7500 hours of relevant experience (850 on type).

Procedure
The four crew members were interviewed separately at their helicopter base. Each participant provided a high level overview of the incident and the cognitive probes were asked in relation to the decision making made during the incident. The interviews were audio recorded and later transcribed. The interviews took place six months after the critical incident occurred.

Data analysis
Deductive thematical analysis has been employed in this study whereby data was classified into meaningful themes which were generated from existing theory (Boyatzis, 1998). In accordance with the objectives of this paper, the coding scheme was based on the three categories of the PCM (see Table 2). The text segments obtained from the CDM transcripts were coded for instances of the themes identified in the coding scheme (Table 2). The data was used to understand individual perceptual cycle processes and to explore how a team PCM can be represented.

<table>
<thead>
<tr>
<th>Code name</th>
<th>Schema</th>
<th>Action</th>
<th>World</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition</td>
<td>Mental structures held by individuals that organise their representations of the world.</td>
<td>The process or statement of doing something, or the intention to do something.</td>
<td>Externally available information in the world (environment).</td>
</tr>
<tr>
<td>Description (for coding)</td>
<td>Statements relating to the use of prior knowledge and experience, i.e. things based on experience, expectation or ‘knowing’ things (this could be implied information through the discussion of training and/or standard operating procedures)</td>
<td>Statements of doing an action or discussion about potential actions that could be taken.</td>
<td>Statements relating to potential or actual information existing in the world (environment). These can be physical things, conditions or states of being.</td>
</tr>
<tr>
<td>Example</td>
<td>“my expectation was that the engine would take a while to start in the rain”</td>
<td>“I turned on the engine”</td>
<td>“Caution light came on”</td>
</tr>
</tbody>
</table>

A PERCEPTUAL CYCLE REPRESENTATION OF TEAM PROCESSES
The incident occurred when flying an AW139 helicopter as part of a routine SAR winch training exercise over a vessel. The WM was out of the aircraft and over the vessel when the pilots were altered to a problem with the EOT, the high temperature meant the crew had one minute of flight time before the engine had to be shutdown. The WM had to be rapidly returned to the helicopter. Transitioning from the hover into forward flight caused air to circulate and naturally cool the engine oil which gave the pilots thirty minutes flying time so the decision was made to return to base which was ten minutes away.
As part of the CDM procedure the incident was broken down into seven distinct phases: Briefing, dummy run, live run, onset of critical incident (EOT problem), immediate actions (training aborted), diagnostics and return to base. Due to the space constraints only the team’s perceptual cycle for dealing with the onset of the critical
incident will be considered. Figure 1 and the associated discussion exemplifies the perceptual cycle that each individual crew member engaged with at this phase of the incident.

Both pilots were alerted to the fact there was a problem with the EOT by indications in the cockpit (flashing amber caution light and text appearing on Primary Flight Display). The WO and WM were not privy to this information so they were alerted to the problem from communications made by the PF; the actions of the PF becomes world information for the WO and WM. It is clear that each individual possesses a schema for the situation that is relevant to their situation. For example, when the incident occurred the WM was deployed on the winch so his schema, based on similar past experiences, is that he will be winched up and his resulting action is to remain quiet so that the crew can deal with the situation. Similarly, the world information of hearing “high EOT” activates what the WO described as an instinct, i.e. he knew what had to be done based on the world information he was exposed to. The most interesting difference between crew members lies between the two pilots who, for the same situation (EOT problem), have very different schemata. For the PF the onset of the problem activates a generic training schema, i.e. the level the EOT had reached meant that they only had one minute of flight time before an engine had to be shut down. However, the PNF had experienced the same problem three weeks earlier and therefore his activated schema was that this was not a critical fault and was most likely to be a spurious indication, which he verbalised to the PF.

Figure 2. Team Perceptual Cycle Model
The PF and PNF would have been exposed to very similar, if not identical, training. This example therefore demonstrates the unique, individual, nature of schemata and the potential influence of schemata in decision making: due to the activated schemata, the PF was in a ‘react now’ frame of mind, whereas the PNF was more relaxed about the situation as his schema led him to believe it was spurious. If the PNF had been PF that day (and therefore would have had ultimate responsibility for the decisions made) he would have still reacted immediately because standard operating procedures are designed to prescribe a clear way of reacting. However, it is still interesting to so clearly see differences between crew members in terms of the perceptual cycles each are engaged with and it demonstrates that the potential exists within a team to make inappropriate decisions based on the viewpoint of one team member. Figure 2 exemplifies the PCM from a team point of view. Each individual team member makes a contribution to the central part of the model which represents the overall team perceptual cycle; the EOT problem activated existing schemata that were developed as a result of previous training and experiences and the actions taken to deal with this resulted in the training being aborted.

CONCLUSION
This paper intended to demonstrate the importance of considering the whole team in the context of the PCM, which is a model that has been previously used in decision making research but with little consideration to team processes. As expected, with exploratory work, this case study has highlighted further areas to investigate. A basic illustration of the approach is provided in Fig.2; highlighting how each team member contributes to an overall team perceptual cycle. However, future work is intended to further refine this, both diagrammatically and in understanding the processes at play. For example, as part of a model to explain schema-driven everyday activity, Norman and Shallice (1986) discussed the process of contention scheduling. This is the process by which competing schemata are prioritised based on strength of activation and motivations of the individual. In a team situation new elements are added: motivations of the team and individual team member’s roles and dominances. Future work intends to explore how contention scheduling works in teams and this will be particularly relevant in ambiguous or spatially remote teams where a clear leader is not apparent. Other authors, for example, Reason (1990) have proposed additional schema-based processes such as similarity matching and frequency gambling. Again, it will be interesting to see how these processes manifest at the team level. Much has been researched and documented about the processes involved at the level of individual micro-cognition. What is less well known is how these processes translate to team behaviour at a macro-level. This paper has looked at this in the context of the perceptual cycle and future work intends to answer some of the questions the research has highlighted.

ACKNOWLEDGMENTS
The authors would like to thank the pilots who were interviewed and Mike Howell who assisted with the illustrations.

REFERENCES