Video-cued recall: its use in a Work Domain Analysis

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A Work Domain Analysis involves the context independent representation of work domain resources as a field for action. However, formal knowledge may not represent all of the resources available to workers in practice. Thus expert knowledge is essential to an accurate inventory of work domain resources. Most knowledge elicitation methods involve self-reports, which are subject to bias. This paper presents video-cued recall as a technique that may reduce bias. This technique proved useful as part of a Work Domain Analysis of the intensive care unit patient work domain.

INTRODUCTION

This paper presents the video-cued recall technique as a method that reduces bias in self-report protocols and shows how this technique was used to capture work domain resources of relevance to a Work Domain Analysis (WDA). A WDA (Rasmussen et al 1994; Vicente, 1999) describes work domains as fields of resources. Completing a WDA involves organizing available resources within a matrix framework, which is comprised of two axes: the Decomposition Hierarchy and the Abstraction Hierarchy. The analyst maps identified resources to cells within a WDA matrix.

Miller and Sanderson (2003) developed a WDA matrix (the Recursive Diagnostic Framework - RDF), for describing patients as independent work domains within an Intensive Care Unit (ICU). The RDF matrix was developed in response to issues emerging from two pioneering attempts to apply the conventional WDA matrix in the operating room (Hajdukiewicz, 1998) and in neonatal intensive care (Sharp, 1996). The alternative WDA formalism is discussed elsewhere (Miller, 2004).

Where the conventional WDA matrix is established (Rasmussen et al 1994), the RDF matrix dimensions needed to be defined. The levels of the Recursive Hierarchy, which is similar in principle to the Decomposition Hierarchy, were defined using formal knowledge i.e. textbooks. In non-surgical health care, clinical abstraction appears to be based on black box reasoning (Ashby, 1956). Clinicians recognise patient signs and symptoms and matching these to formal diagnostic templates. Klein's (1998) Recognition Primed Decision (RPD) model (Fig. 1) appeared to capture this aspect of clinical conceptualisation and the RPD model was used as the basis of the abstract conceptualisation axis of the RDF (see Table 1).

The RPD model is comprised of two types of elements. The grey nodes (Fig. 1) represent elements that are used in decision-making and as activity are *not* included in a WDA. The black nodes (Fig. 1) are information and other resources in an environment upon or about which decisions are made (Miller, 2004). The black nodes are relevant to WDA because they are the resources that make up the field upon which clinicians act (Vicente, 1999). Given these distinctions it logically follows that if decision elements could be separated from resource elements we would be left with context independent resources as required by WDA.

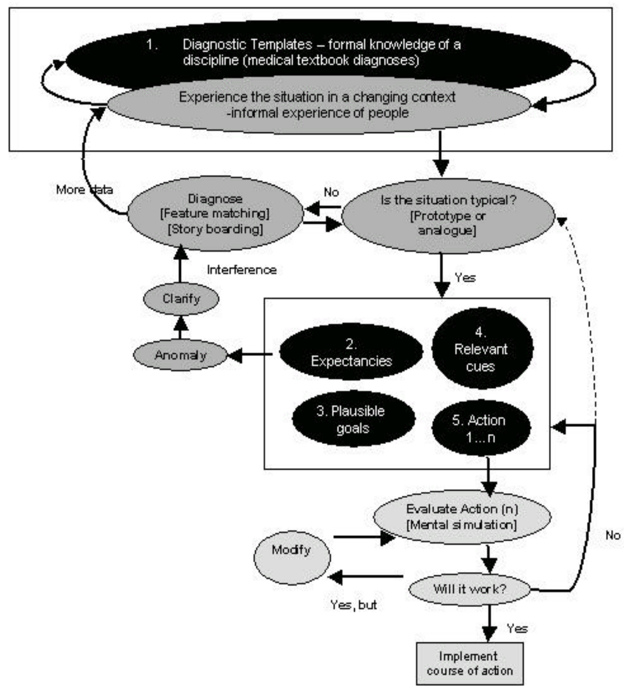

Figure 1. The Recognition Primed Decision model, modified from Klein (1998)

Researchers using WDA have used different approaches for identifying work domain resources. Rasmussen (1979, 1986), Sharp (1996), Burns, Bryant and Chalmers (2002) developed a WDA matrix based on codified worker experience. Naikar and Sanderson (2001), Bisantz, Burns and Roth (2002) based their WDA matrix on system design specifications, while Hajdukiewicz (1998) used formal medical knowledge. Each approach has its strengths and limitations. Relying on the retrospective self-reports risks distortion due to subjective biases (Hoffman, Shadbolt, Burton & Klein, 1995). Omodei, McLennan and Wearing, (in press) further maintain that retrospective self-reports may be distorted because a) pre-verbal perceptual and motivational states may be omitted from recall, b) negative self-assessment experiences may not be recalled due to self-protection processes, and c) because retrospective recall is subject to hindsight bias (Hoffman et al). These issues would suggest that formal knowledge acquisition sources are preferred.

However, Crandall and Getchell-Reiter (1993) discovered differences between textbook descriptions of the symptoms of neonatal sepsis and the symptoms identified in practice by nurses. Flach (2000) points out that formal descriptions may be only abstractly related to work in practice. In practice expert workers have acquired complex knowledge about resources and their interactions through experience. Important interactions may not always be discoverable using general textbooks. For these reasons the expert knowledge was considered to be central to developing a comprehensive ICU patient WDA matrix. The challenge was to reduce the effects of distortion in self-report data collection. McLennan, Omodei, Rich, and Wearing (1997) and McLennan, Omodei, and Wearing, (2000) developed the video-cued recall technique to reduce distortion in self-report protocols and have used this technique to study decision making among fire-fighters.

Video-cued recall is a three-step process. In Step 1 the participant wears a head-mounted audio-video recording apparatus during a real event – the equipment records the visual and auditory cues attended to by the participant. Step 2 occurs soon after the recorded event and involves replaying the Step 1 recording to the participant. Replaying the audio-visual recordings immerses the participant back into the event. Ordinarily the participant free-recalls any recollections they might have in response to the recordings while suspending analysis and evaluation. This session is again recorded. In Step 3, the recordings taken during Step 2 are replayed to participants. Step 3 probes fundamental processes including errors and decision strategies.

Based on their research Omodei et al (in press) maintain that video-cued recall reduces self-report bias because: a) re-immersion generates a more representative set of recollections with less self-defensive justification and editing than memory alone; b) head mounted recordings reduce self-assessment and therefore self-protective attributions and selective reporting that may occur when one is an observer of ones own behaviour, c) during recording the head mounted apparatus does not appear to stimulate the self-consciousness that is experienced when a video camera is focussed on oneself, and because the participant's behaviour proceeds normally during the event, others do not appear to demonstrate self-consciousness either. Video-cued recall has not been used in a WDA. For the ICU patient work domain the promise offered by video-cued recall of a comprehensive and detailed data set with reduced risks of distortion was the major reason for its use. Highly detailed transcripts also offered control and flexibility in data collation and coding.

This paper is divided into two subsequent sections. The method section presents the video-cued recall procedure and the data coding and collation processes used to complete a WDA matrix of ICU patients. The results and discussion section provides an overview of the outcome of this process, including its limitations and implications for future research.

Method

This section describes the video-cued recall procedure conducted at the Epworth Hospital ICU in Melbourne, Australia between November 2000 and May 2001 with Ethics Committee approval.

Participants

Eight senior intensive care doctors, 17 senior intensive care nurses and five critically ill patients took part for the duration of the patient's admission. The participating patients were representative of intensive care patients (one suffered acute pancreatitis; two suffered septic shock with multiple organ failure, one patient presented with a blastic transformation (relapsed leukaemia) and one patient had a closed head injury). Three patients were discharged to general wards, one died later in a general ward from unrelated causes and one died in the ICU. In total 57 video-cued recall interviews were conducted; 27 for nurses and 30 for doctors.

Materials

Two sets of materials were used in the study. The head mounted audio-video camera (Fig 2) and the materials used during the recall interview (Fig 3).

Procedure

The purpose of the video-cued recall procedure was to capture ICU patient related work domain resources. In order to capture the most comprehensive range of resources two resource intensive events were identified, namely, the morning nurse handover (7:00am) and care team ward round (8:30am). Immediately prior to the handover the researcher fitted the head-mounted recording equipment to the oncoming nurse participant and then left the area. Approximately 30minutes later the researcher collected the recording equipment, thereby completing Step 1, and arranged an interview time in a quiet back room later in the morning.

Prior to the Step 2 interview the camera with the handover recording was connected to the TV monitor and VHS recorder with a new VHS tape inside. Following an introduction, the nurse was given a remote control device so that she could control the rate of the recording replay. The VHS recorder was set to 'record' so that the interview and the camera recording linked to the TV monitor could be recorded. The nurse was instructed to replay the recording. Because available resources were the focus of this study the researcher asked the nurse to focus recall on resource use. During recall the researcher probed for additional resources using prompts such as 'Is that the only data that would tell you that…?'; 'You mentioned adrenaline, is that the only drug you would use?' The purpose here was to probe the limits of resource relationships. Thus the video-cued recall interview used in this study integrated Omodei et al's (in press) Steps 2 and 3.

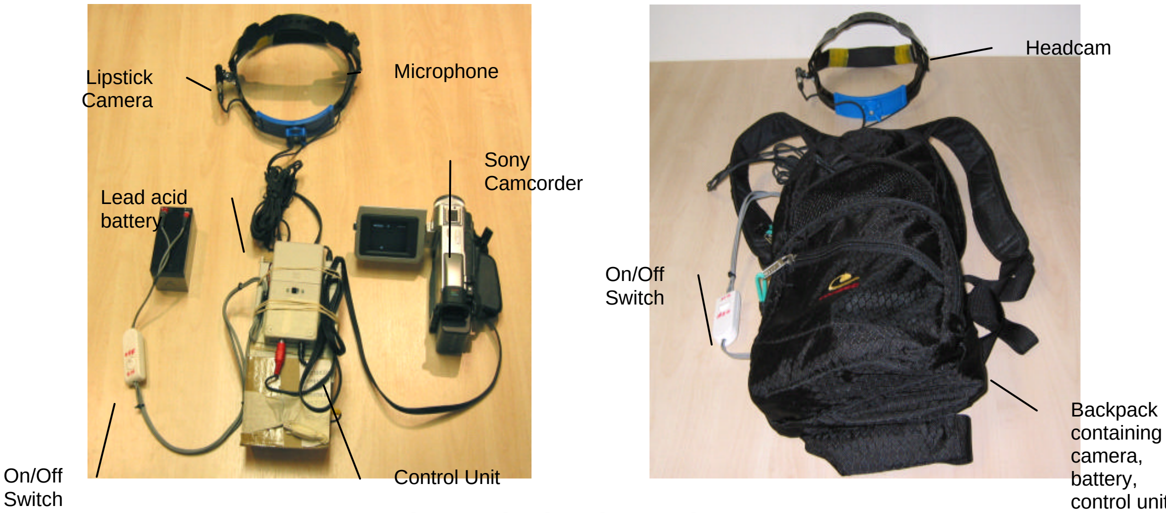

Figure 2. Head-mounted audio-video recording equipment, unpacked and packed into a light-weight back-pack.

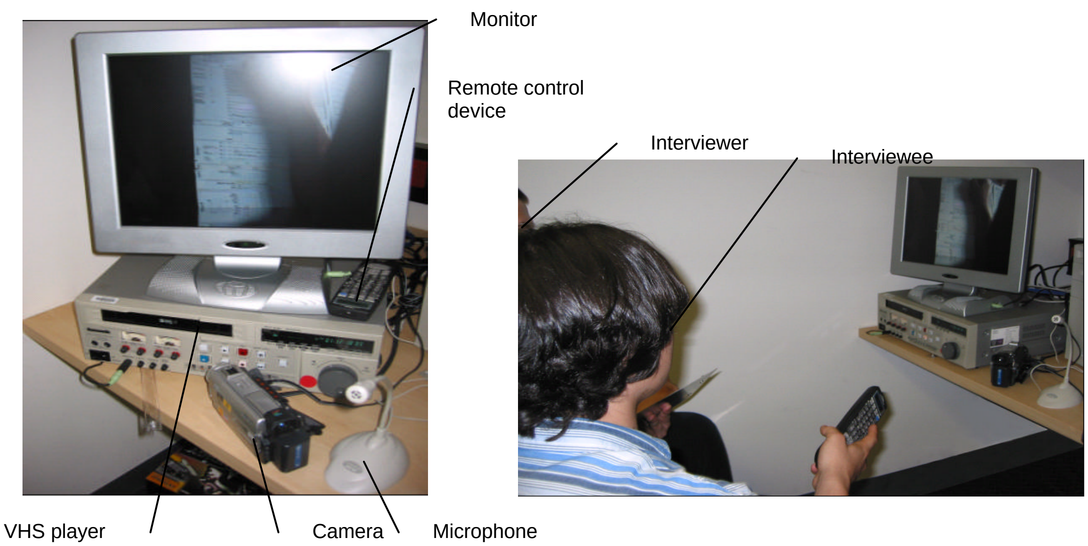

Figure 3. Recall interview set up

Given that resource identification and mapping as opposed to an exploration of the situational context or the inner experience of the participant was of primary concern integrating Steps 2 and 3 was considered to be appropriate. Exactly the same procedure was used for doctors.

Data collation, coding and analysis

Following the interview the VHS tape was manually transcribed into HTML pages and divided into speech units (Hill & O'Brien, 1999). Prior to transcript coding, a coding scheme that operationalised the elements of situation (black nodes in Fig. 1) was developed based on definitions given by Klein (1998). The coding scheme was subjected to an inter-coder reliability study involving three coders: the researcher, an independent senior intensive care nurse and a clinical psychologist. Cohen's kappa of 0.72 was obtained between the researcher and the nurse. Cohen's kappa between the clinical psychologist and the nurse and researcher were both less than 0.5, suggesting that the coding scheme could be reliably applied but only by domain familiar coders.

The researcher coded all relevant speech units in the 57 transcripts. Each speech unit was given two codes, one for each axis in the RDF. In this way decision elements (the grey nodes in Fig 1) were separated from the information and other resource elements in the environment (black nodes in Fig 2). Once coded, the transcripts were submitted to Leximancer- a text-based data analysis tool (Smith, 2000a; 2000b). Using Leximancer the coded speech units were aggregated across patients, across nurses, across doctors, for each patient day and overall. Once aggregated the coded speech units were sorted

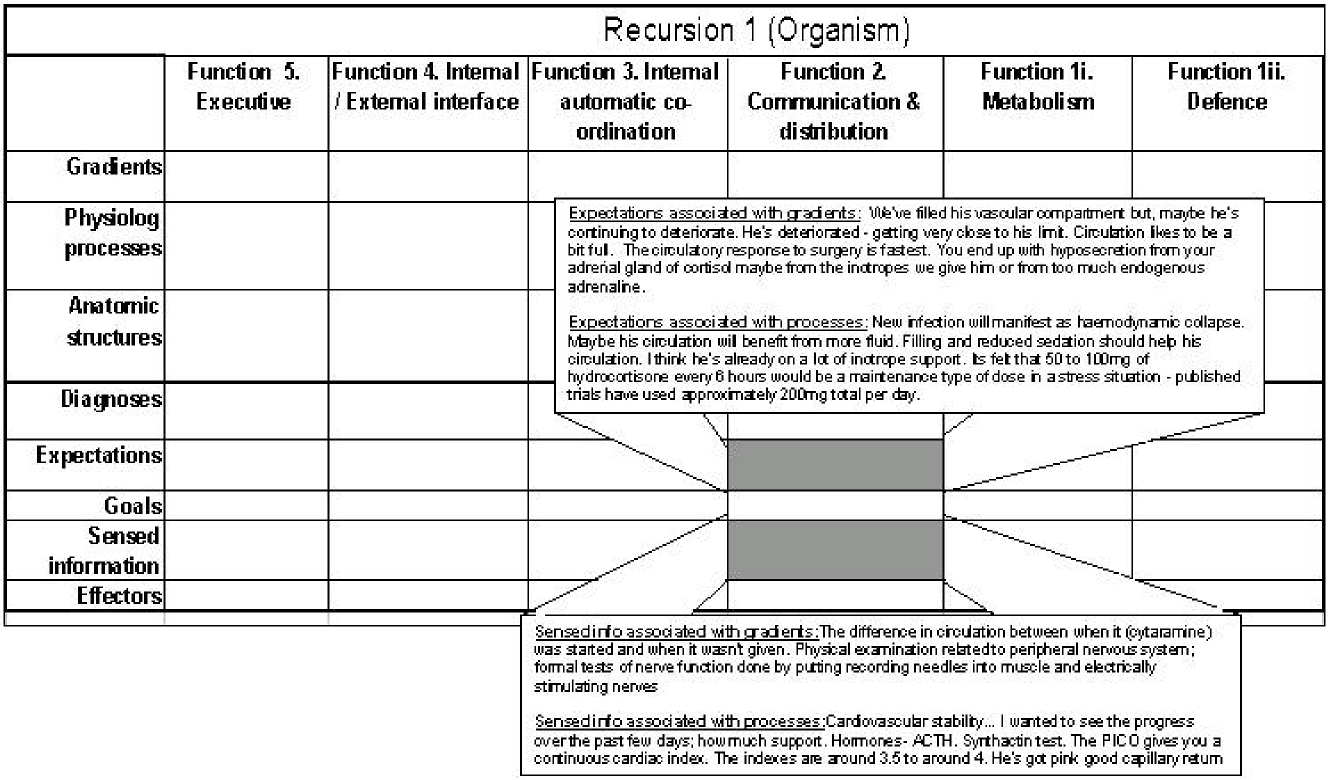

Table 1. An example of the inventory of speech units located within the WDA matrix.

and located within each RDF matrix cell. Editing reduced duplication. Table 1 provides a very small part of what is a large inventory of speech units.

Results & discussion

A WDA presents the field upon which action occurs independently of any particular state, task, event or worker. In surgical contexts where anatomical structures characterise the work domain, a conventional WDA may be quite appropriate because anatomical structures are well known and largely invariant across patients. Non-surgical health care contexts present challenges. Medical knowledge continues to evolve, and gaps, as Crandall and Getchell-Reiter, (1993) found exist between the resources presented in textbooks and resources used in practice. Thus a WDA that accurately reflects the available resources in patient work domains inevitably requires expert practitioner input.

However, participant characteristics may distort knowledge elicitation processes. Omission through simple forgetting and active editing for reasons of self-protection were the most likely threat to a comprehensive WDA. We also needed to understand the relationships between resources as used in practice – how sensors were discussed with other sensors for example.

The video-cued recall technique appeared to reduce self-report distortions in the following ways.

- Head mounted audio-video recording equipment captured as closely as possible the cues that were available and attended to by the participants. Replaying these cues also made them available to the researcher and provided a basis for probing that was not possible during the real time event. Using the recordings the researcher did not depend as much on what participants volunteered without such cues.
- Video recordings taken from a head mounted camera did not include images of the practitioner other than the practitioner's hands. Thus practitioners were not required to observe, justify or defend their own behaviour. They could also attend to the substance and content of the replayed recordings with less distraction.

Video-cued recall does not reduce bias to zero. The quantitative extent to which it does affect bias remains to be addressed. It may be impossible to completely eliminate bias. Anecdotally however, the immersive power of replaying the head mounted recording appeared to be strong for some participants. Several engaged in free-recall to a greater extent than others, and were observed to utter uncensored comments, such as " I know he's going to say it … he always says that and here it comes [recorded verbalisation]… I wish he would just… woops! Sorry!" On realising what they had said participants explained that that had been what they had been thinking at the time and would we please edit those comments out. Participants also expressed self-questioning and answering behaviour as in this passage: "[only background noise audible on the recording] I was thinking yesterday that if his…went up then… and yes here it is [hand holding pencil points to a lab result]… but it's not as much as I would have thought [flips to yesterday's report]… I'm thinking perhaps we should… [a request for an additional test is verbalised on the recording]. During the recall interview participants tended fill in recorded silences with what appeared to be their thoughts at the time.

The inter-coder results suggest another potential source of distortion in coding and collation. Coding agreement was highest among domain experts with less than 50% agreement between the experts and the non-domain expert coder. Expert knowledge and language is acquired over many years and is arguably very subtle. Common terms such as 'temperature' assume multiple highly domain specific meanings. 'Temperature' may be sensed information, 37 degrees for example; a patient may have a 'temperature' that is a diagnosis of fever. It was coding disagreements on terms such as this that were most responsible for low levels of agreement between expert and non-expert coders. Generalising this finding it is possible that analyst mis-interpretation of expert knowledge may lead to significant distortion in expert knowledge data collation which may affect the accuracy of modelling frameworks such as a WDA. The extent to which this is a problem remains for future research.

This research was not concerned about specific patient situations or the experiences of participants because WDA simply represents the field upon which different patient situations and actions can occur without reference to any of these. The transcript coding and data manipulation scheme was designed to separate elements of situation (black nodes in Fig 1) from elements of decision-making (grey nodes in Fig 1), which are not included in a WDA. However as found by McLennan et al, (1997) in relation to naturalistic decision making among fire-fighters, recall interviews can provide considerable insight into practice-based reasoning and problem solving strategies, which are fields of research that are not generally associated with a WDA. Thus recall interviews may provide further insights into the nature of clinical abstraction in complex medical domains.

In conclusion video-cued recall was useful as a technique for extracting information and other resources from expert practitioners in ways that reduced participant and possibly analyst distortion. Transcripts from the recall interviews were coded and processed in ways that were relevant to a WDA.

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