Use of tactile alerting systems for rail infrastructure workers.

Vincent Galea, Australian National University, Transport for NSW, AUSTRALIA

Gysbert Koens, Transport of NSW, AUSTRALIA.

Introduction: Rail infrastructure and track workers operate in a dangerous environment where movement of trains through the worksite is a constant and significant hazard. Although various levels of protection can be put in place through rail network protocols, the risk of these systems failing can result in potentially disastrous consequences. Current warning systems incorporate visual and auditory signals, but these may be compromised by the nature of the work being undertaken. For example, workers are typically using dangerous equipment and therefore must visually concentrate on the work in hand in order to remain safe. The worksite is also normally very noisy requiring the wearing of ear protection which effectively mutes auditory alerts. Environmental considerations also have to be considered - high volume auditory warnings will severely impact on other workers and nearby residents. The use of tactile signals directed to individual workers may be a solution to this issue, especially if linked to individual auditory alerts.

Practice Innovation: The tactile sense has the advantage of a large transduction surface area (Mortimer, Zets, & Cholewia, 2007) and a peri-personal space advantage (the ‘tap on the shoulder’ effect) (Ho & Spence, 2009; Spence, Pavani, Maravita, & Holmes, 2004) which imparts an urgency and thus shorter reaction time. Contemporary research and applications have used vibration signals operating on the Pacinian channel (‘tactons’) which vary both amplitude and tempo to enable different patterns which can then be associated with the required alerting functions (Brewster & Brown, 2004). The poor discrimination ability and limited bandwidth of the tactile system for frequency (G.A. Gescheider, Bolanowski, & Hardick, 2001; G. A. Gescheider, Bolanowski, & Verrillo, 2004) has limited the application of this domain as compared to the auditory modality where frequency is a fundamental aspect of a signal. Many tactile signals are therefore abstract patterns which are then linked to meaning without the iconic structures available in the auditory and visual modalities. In addition, whilst recent studies have shed light on inattentional blindness (Most, Scholl, Clifford, & Simons, 2005; Pizzighello, 2009) and deafness (Dalton & Fraenkel, 2012; Macdonald & Lavie, 2011) little is known of any inattention effect for the tactile modality.

These aspects must be studied and understood before tactile alerts can be reliably applied to rail track worker protection or any other safety critical function. This research project aims to fill this gap so that any initiatives can be applied with confidence.

Findings: It is hypothesised that linking the (albeit limited) tactile frequency domain of a signal to its auditory counterpart will increase the congruence of signals and aid in their identification and memory, in effect, providing some form of iconic structure to tactile signals similar to what has been shown for visual/auditory signal linkage (Grassi & Casco, 2010; Peters & Itti, 2007). It is further hypothesised that the peri-personal nature of tactile signals will exhibit less inattentional effects than the auditory or visual modalities (Macdonald & Lavie, 2011).
Discussion: If these major hypotheses are correct, the tactile modality may be the key to capturing attention for critical functions such as rail track worker safety. By linking already known alerts in the auditory and visual modalities to tactile, an integrated warning structure can be achieved with all modalities working together to provide reliable, overlapping and congruent signals which will then provide redundancy and/or reinforcement in a broad range of safety critical applications.

Human Factors topics covered: Safety systems management, tactile information, multi-modal interaction, perception, cognition, attention, inattention, iconic signals, congruence, organisational dynamics, workgroup participation.

References:


