Direct and Indirect Methods for Measuring Audience Reactions to Contemporary Dance

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Contemporary dance – an artform where the major medium is movement, deliberately and systematically cultivated for its own sake – provides a complex, challenging but rich context for investigation of human perception and cognition (Hanna, 2008; McCarthy et al. 2006). In this paper, we outline two different techniques that have been applied to gauge psychological responses to Australian contemporary dance. The first direct and explicit questionnaire method can be administered after a live or recorded performance, and the second indirect, implicit method is useful in the context of dance film. Both techniques may be used to record and analyse perceptual and psychological responses to other artforms such as music, drama, cinema, new media, and multimedia. Detailed explanatory reports of the techniques are in the process of being published (Glass, 2006; Stevens et al. 2010).

The Audience Response Tool (ART): a new psychometric instrument for measuring audience reactions

A large-scale experimental investigation of audience response (Glass, 2006) involved the systematic manipulation of three variables or factors, choreographic intention (representational versus abstract), audience member expertise (dance experts, 10 years dance training, versus dance novices), and pre-performance information (generic information session, specific information session, no information session – control group). Four hundred and seventy-two audience members formed the sample for the experiment with sessions conducted over a period of six months. Two new Australian works were used as stimulus material with data collected from audiences attending one of seven live performances in city and regional centres in Australia. Approximately half of each audience arrived early to receive either a generic or specific information session concerning the work they were about to see. The generic information sessions provided information about contemporary dance in general whereas the specific information sessions provided information tailored to each of two different works. The information sessions were presented by dance writers and artists McKechnie, Grove, and Healey, and included examples of movement performed by dancers live or on video. The remainder of each audience arrived just before the performance, forming a control group for the information variable (i.e. the control group received no information other than the title of the work and brief program notes). The two dance works were *Red Rain*, a narrative piece choreographed by Anna Smith and a more abstract work *Fine Line Terrain* choreographed by Sue Healey.

To evaluate information session effectiveness, we developed the Audience Response Tool (ART) – a psychometric instrument for gathering psychological reactions to live or recorded performance (Glass, 2005, 2006). The ART consists of three broad sections: a qualitative section that explores cognitive, emotional and affective reactions, a quantitative section that includes a series of rating scales that assess cognitive, emotional, visceral and affective responses, and a demographic and background information section (e.g., age, gender, dance experience, etc.).

Exhaustive qualitative and quantitative analyses of open-ended responses demonstrated that approximately 90% of participants formed an interpretation of the dance work that they saw (Glass, 2006). For the observer, contemporary dance can be viewed as non-representational or representational and various cognitive strategies may be called upon to extract representational content including (i) thematic analysis, (ii) metaphor, (iii) imagery, (iv) narrative-searching, and (v) personal memory. Some of the cues used to form an interpretation included visual elements, aural elements, movement, and the use of space; Table 1 shows that the relative contribution of these elements in the two works differed (Glass, 2005, 2006). Information sessions did not impact on the tendency to engage with the piece but specific information sessions did impact on the content of interpreted responses.

Table 1: Cues used to form an interpretation (Glass, 2006)

Cue	*Red Rain* (%)	*Fine Line Terrain* (%)
Visual elements	40.5	35.9
Aural elements	31.4	35.9
Movement	31.4	< 10
Use of space	< 10	63.1

More than 87% of participants reported that they felt an emotional response. The results indicated that contemporary dance is a multi-layered event with numerous avenues for emotional and affective communication. Some of the reasons for the experience of emotion and enjoyment, as stated by participants, included visual and aural cues, dancer characteristics, movement, choreography, novelty, spatial/dynamic elements, emotional recognition, intellectual stimulation, the piece generally, and emotional stimulation (see Table 2). Audience members also noted higher-order relations between cues as being important for their enjoyment. For example, relations between dancer movement and music were mentioned; movement and music appear to embody motion expressed through structural variables such as dynamics and time (Glass, 2006). Interestingly, some of the processes that we had observed during creation of a new dance work (Smith's *Red Rain* discussed in Stevens et al. 2003) are active as audience members watch contemporary dance – processes such as association, analogical transfer, synthesis and functional inference. Creative thinking was evident not only in the context of observers watching Smith's *Red Rain* (the dance work that we had studied earlier from the perspective of creative choreographic cognition) but also in the context of a more abstract piece, Healey's *Fine Line Terrain.*

The ART elicited extremely detailed and informative descriptions from participants. Surprisingly, in these descriptions we saw minimal effects of dance expertise suggesting that other methods are required to elicit the kind of knowledge that characterises people with extensive experience performing or teaching dance. Expertise from other domains such as history may also influence responding but an analysis of different types of expertise was beyond the scope of the present study. Specialist dance knowledge is likely to be procedural and implicit rather than declarative and explicit, and oriented to the kinaesthetic and to shapes and forms in space and time (Allard & Starkes, 1991; Stevens, 2005; Stevens et al. 2003; Stevens & McKechnie, 2005). If this is the case then other kinds of non-verbal methods are needed to obtain measurable effects of dancer expertise.

Table 2. Reasons for enjoyment (Glass, 2006)

Cue	*Red Rain* (%)	*Fine Line Terrain* (%)
Visual	32.4	51.3
Aural	28.4	28.3
Dancer characteristics	28.0	39.5
Movement	25.6	36.8
Choreography	10.0	18.4
Interpretation	7.6	25.0
Emotional recognition	3.6	6.6
Novelty	15.2	11.2
Spatial/dynamic	14.4	26.3
Intellectual stimulation	14.4	7.9
Piece generally	5.6	3.9
Emotional stimulation	7.6	9.2

Recording and analysing overt visual attention offers another lens on dance cognition. Eye movements provide detailed quantitative information about moment-to-moment attention, implicit knowledge, and expectations about a specialist domain such as dance. In a laboratory experiment, we recorded eye movements (saccades) and eye fixations from expert and novice dance observers as they watched a five-minute dance film under controlled conditions.

Eye movements and expertise – an on-line, indirect method for measuring observer response, acquired expectations and abstract implicit knowledge

In another of the temporal arts – music – implicit knowledge about common features of the genre generates expectations. Variations in how these expectations are met or violated are important in determining emotional and aesthetic response to music (Francès, 1958; Huron, 2006; Krumhansl, 1979; Meyer, 1956; Tillmann, Bharucha & Bigand, 2000).

Differentiation between two kinds of expectations – schematic and veridical – solves a paradox of musical expectation (Bharucha, 1994). A familiar piece of music contains no surprises. If the violation of expectations is aesthetically or emotionally important then a piece should become less aesthetically or emotionally interesting with each listen. This is not the case. Schematic expectations are automatic, culturally generic, and develop from assimilation of abstracted regularities of the music of a genre, over years of experience. Veridical expectations refer to the actual next event in a familiar piece even though the event may be schematically unexpected. Because schematic expectations are acquired from hearing many individual pieces the two kinds of expectations will often converge but, at times, diverge, creating a continuing sense of violation in familiar pieces of music. There is a tension between what one expects and what one hears and this tension contributes to emotional response to music (Meyer, 1956).

Hagendoorn (2004) has theorised an interplay of expectations concerning human biological motion and particular choreographic styles or works elicited by movement trajectories as dancers watch dance. The empirical challenge is to develop a behavioural method where expectations can be elicited and quantified. Patterns of eye fixations and saccades (eye movements) appear to differentiate novices and experts in cognitively demanding domains such as reading and chess and dynamic environments such as driving, aviation, and sport. Thus, some of the forms of knowledge that distinguish novice and more expert observers of dance may begin to be inferred from differential patterns of fixation and saccades while watching dance.

Eye movements as indices of visual attention, expertise, and long-term memory

Eye movements provide detailed, quantitative information about moment-to-moment visual attention. Although rapid covert shifts of attention do not necessarily involve eye movements (Abernethy, 1988; Posner et al. 1980; Remington, 1980), the pattern of eye fixations and the trajectory of eye movements are informative behavioural indicators of aspects of visual selective attention. Fixation time measures the processing time given to overtly attended regions. Longer times are often associated with more interesting, puzzling or difficult material (Rayner, 1998; Yarbus, 1967), and are likely to be influenced by observer expertise.

For example, novice pilots dwell nearly twice as long as experts on the information-rich attitude directional indicator, requiring more time to extract less obvious information (Bellenkes et al. 1997) and novice car drivers record longer head-down dwells than experts (Wikman et al. 1998). Effects of expertise have also been observed in saccades (eye movements) and scanpaths: short latencies for an initial saccade distinguish good from poor cricket batting (Land & McLeod, 2000); and expert radiologists prioritise their attention, scanning areas where tumours are most likely to occur while the novice scans an x-ray plate evenly (Kundel & La Follette, 1972).

The cognitive processes inferred from these patterns of eye movements in experts relative to novices include encoding configurations rather than individual elements, and guidance from peripheral vision. Movement in the periphery will prompt saccades (Fitzpatrick, 1990). Like expert pilots and athletes, it is likely that dance experts have access to knowledge in long-term memory of dance schemata and expectancies that guide visual perception and interpretation. Comparing expert and novice dance teachers, Petrakis (1987) found no significant differences in fixation durations but some differences in search patterns. For example, novice dance teachers concentrated on the lower body while the expert teachers attended to the upper body. The present study differs in that participant groups are qualitatively different with respect to experience and expertise with contemporary dance.

Investigations of memory for dance movement suggest that those with experience performing and observing dance have better recall than novices of movement that is choreographed or structured (e.g., Jean et al. 2001; Starkes et al. 1987, 1990). Differences between expert and novice dancers have also been demonstrated with respect to body image, cognitive imagery, and spatial ability (Overby, 1990). Most recently, neuroimaging studies have shed light on effects of specialist dance expertise on action observation and motor simulation (Calvo-Merino et al. 2005, 2006). For adults, it is also likely that there are schematic expectancies pertaining to biological motion, anatomically possible human movement, dynamics of motion including gravity and other forces (e.g., Dittrich et al. 1996; Grossman, Blake, & Kim, 2004; Neri, Morrone & Burr, 1998).

For individuals with experience performing and observing contemporary dance, it is anticipated that perception is rapid and with the encoding of configurations and phrases more than discrete units. Knowledge in long-term memory acquired from experience with the artform guides this perceptual organisation. Accordingly, it is hypothesised that expert observers fixate for shorter times and have faster saccades than novice observers.

Aim, design and hypotheses

Our aim was to investigate the effect of expertise (novice, expert) and viewing session (first, second) on overt visual attention while watching a filmed performance of contemporary dance. The dependent measures were fixation time and average saccadic velocity; regions of fixation were recorded. Based on eye movement correlates of expertise, it was hypothesised that: i) fixation times recorded by expert observers are shorter than those of novice observers; ii) average saccadic velocity recorded by experts is greater than that of novices. If observers develop veridical expectations for a particular dance piece, then responses will differ across viewing sessions and, more specifically, response patterns from novice observers will move towards those of expert observers during a second viewing session.

Method

Participants

The sample consisted of eight female participants (average or mean (M) age=28.63 years, Standard Deviation (*SD) or variability*=6.12), four with extensive dance training (*M*=19.5 years, *SD*=3.87) and dance performance experience (*M*=13.5 years, *SD*=5.20), and four with no dance training.

Stimuli

The stimulus material was a five-minute contemporary dance film *13 & 32* choreographed by Sue Healey, commissioned especially for this project. The dance film, shot from a single camera angle to control viewpoint, was of a light-hearted duet between James Batchelor (13 years) and Tom Hodgson (32 years). Choreographer Healey used partitions on either side of the frame to provide depth and varied entry and exit points. Darrin Verhagen composed the soundscape that accompanied the film. To constrain the amount of data to be analysed and to ensure comparable cell sizes for analysis, a 17 second section midway through the film (235-252 s) was selected for detailed analysis. The section was chosen as it involved duet work with the dancers working together and apart. In contemporary dance, it is often the case that multiple dancers are performing simultaneously in different regions of the space and producing different dance movements.

Equipment

The film was presented to participants on a desktop PC with external speakers. An EyeLink II pupil-based video monitoring system (SR Research Canada) was used with a sampling rate of 500Hz equivalent to a temporal resolution of 3ms. Viewing was binocular but, as is the convention, data recorded from the right eye were used in analyses.

Procedure

The session commenced with participants reading an information sheet and providing their written consent (University of Western Sydney Human Research Ethics Committee approval HREC05/026). Participants were tested individually and were given a brief introduction to the dance film including its title. They were asked to watch the dance film in the way that they would normally watch a performance. Participants watched the film twice. Between viewings and as a filler task, participants completed a background questionnaire and provided a written description of their reactions to the film. The experiment lasted 40 minutes.

Results

In the analysed segment, the mean number of fixations recorded by experts was 36.50 (*SD*=5.49) and from novices 32.13 (*SD*=6.57). Raw data recorded from the right eye of participants were analysed in two-way (expertise, viewing) analyses of variance (ANOVAs) conducted separately for each of three dependent measures. The first hypothesis, that fixation times recorded by experts are shorter than those of novices, was supported, *F*[i](1,246)=6.91, *p*<0.05 (Figure 1). There was a significant interaction between viewing session and expertise, *F*(1,246)=4.49, *p*<0.05, with a greater difference between expert and novice fixation times during the first viewing of the film relative to the second viewing (Figure 1). Supporting the hypothesis that veridical expectancies develop for a particular piece, fixation times were significantly longer in response to the first viewing of the film (*M*=521.02 ms, *SD*=391.18) than the second viewing (*M*=449.89, *SD*=325.83), *F*(1,246)=5.04, *p*<0.05.

As hypothesised, saccadic average velocity (visual degree per second) recorded by expert observers (*M*=88.06, *SD*=53.64) was greater than that of novice observers (*M*=68.55, *SD*=40.50), *F*(1,246)=22.08, *p*=.000. There was no main effect of viewing session and no interaction between expertise and viewing session (Figure 2). Analysis of saccadic peak velocity revealed an interaction between expertise and viewing session, *F*(1,246)=8.40, *p*=.004. Peak velocity of saccades increased for both participant groups in the second viewing session, with the greatest increase recorded in the expert group.

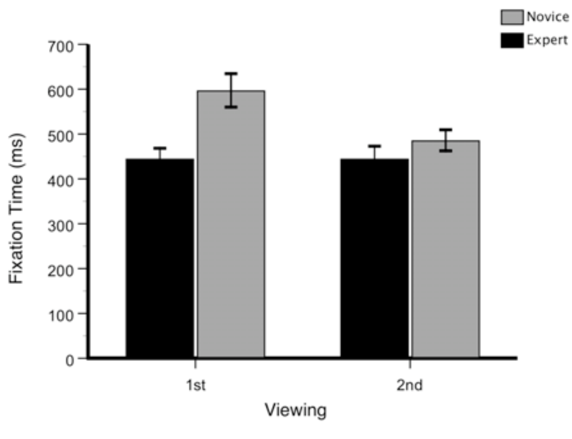

Figure 1. Fixation duration (ms): expertise x viewing session. Error bars show standard error of the mean.

On the second viewing, the differences between fixation times of novice and expert observers decreased. Significant differences in fixation times were recorded by novices between the first and second viewing, *F*(1,123)=7.98, *p*<0.05, with shorter fixation times recorded in the second viewing (*M*=458.85 ms, *SD*=300.89) than in the first (*M*=579.11 ms, *SD*=455.00).

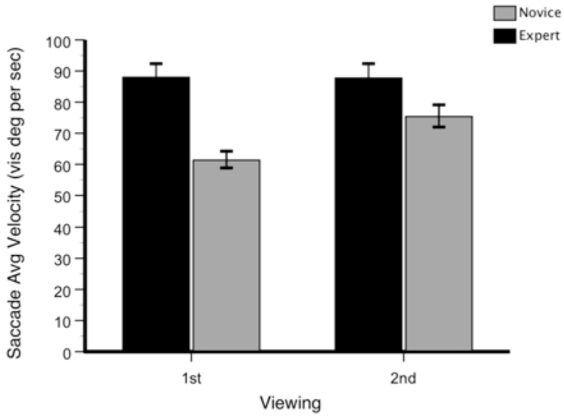

Figure 2. Saccadic average velocity (visual degrees per second): expertise x viewing session. Error bars show standard error of the mean

One possibility is that expert and novices differ in ways other than their amount of experience with contemporary dance and this may also affect eye movements. To check for general differences in eye movements and baseline activity between the two groups, fixation count, duration, and saccade amplitude were analysed from 4 seconds between the title of the film and the dance starting. These data revealed no significant differences between the expert and novice groups.

A research question concerns differential effects of expertise on dwell time and anticipatory eye movements. Custom-written software was used to relate eye fixations to the region of the frame that was fixated. Sixteen regions of interest were specified manually, namely the background and each dancer's head, neck, torso, left and right shoulder, left and right arm, left and right hand, left and right hip, left and right leg, left and right foot. Table 3 shows the mean percentage of dwell time across the 17-second segment devoted to the background and body regions of each dancer that attracted most fixations for expert observers, the choreographer, and novice observers.

Table 3. Percentage of time that regions were fixated

	Region						
Observer	Head 1	L Hip 1	Torso 1	Head 2	Torso 2	B'gnd	Follows
Expert							
View 1	7.30	0	2.48	6.97	12.42	57.87	36.08
View 2	2.70	0.44	4.49	0	13.03	62.85	29.79
Novice							
View 1	2.47	0	1.23	2.20	7.27	73.26	29.87
View 2	1.52	1.15	3.60	0	6.94	72.46	29.01
Choreog.							
View 1	7.27	0	2.18	19.64	3.80	57.14	37.84
View 2	6.40	0	31.64	0	5.35	42.25	54.84

The only significant difference in a comparison of proportions revealed a difference between the amount of time that the background was fixated by experts compared with novices during Session 1, $z(7)$= -.2.89, p< ,05. Although Figures 4 to 6 are descriptive, some observations can be made. First, all observers, whether expert or novice, fixated the background from 57.87 to 73.25% of the time; the choreographer fixated the background between 42.25 and 57.14% of the time. Background fixation decreased from the first to the second viewing for the choreographer but there was negligible change for experts and novices across viewing sessions. When the regions of fixation are considered broadly, there is a tendency for novices to fixate the background while experts spend less time on the background and more time fixating the head and torso regions of the dancers.

The accuracy with which saccades followed the movement was also calculated. The calculation involved comparing the position of a saccade during each movement with the corresponding moving area. The choreographer was most accurate at following the movement (37.84% in Session 1, 54.84% in Session 2), but experts and novices were also successful, following movement from 29.01 to 36.08% of the time.

Discussion

The assumption investigated here was that watching dance develops schematic expectancies based on knowledge of the artform, dance technique and choreographic styles, as well as knowledge of human morphology and movement. The activation of schematic expectations was inferred from a comparison of eye movement patterns from expert and novice dance observers as they watched two viewings of a short dance film. As anticipated, expert dance observers recorded shorter fixation times and faster saccades than novice observers. Novices acquired veridical expectations with shorter fixation times recorded during a second viewing of the film.

Brief fixation times, characteristic of experts, reflect rapid perceptual processing likely guided by expectancies and schemata in long-term memory. Akin to highly skilled pilots (Bellenkes et al. 1997), athletes (Land & McLeod, 2000) and drivers (Wikman et al. 1998), dance experts are adept at abstracting and extracting key information from complex movement material. Visual and motoric knowledge of dance in general and different choreographic styles in particular – schematic expectancies (Bharucha, 1994) – may enable configural rather than elemental encoding, maximising short-term memory. Dance experts made faster saccades than novices using visual cues (and possibly sound) building new expectancies that guided systematic and strategic scanning of a performance. Interestingly, novices fixated regions more rapidly after just one viewing. A single exposure to a short work appears sufficient to establish perceptual reference points and to begin acquisition of veridical expectancies for a particular work (Bharucha, 1994).

An important implication of the present results for audience development and education is the way in which expectancies, even in novice observers, develop during a single viewing of a work. Repeated exposure to dance is likely to build perceptual fluency. Such perceptual fluency becomes associated with a sense of familiarity and ultimately heightened preference for the movement material. Thus repetition of material within a single work or across a body of dance works by a particular choreographer or ensemble is likely to facilitate recognition and enjoyment.

A significant aspect of these results is the way that moment-to-moment cognitive processes have been captured in response to an ephemeral, dynamic, non-verbal, yet communicative artform. Eye movements provided an indirect measure of rapid cognitive processes without the need for verbalisation. Future studies might include strategic manipulation of attentional cues such as soundscape, lighting, spatial arrangement of dancers, and scrutinise the interplay of visual, motor, and semantic knowledge.

Conclusion

Two methods for recording audience response to dance have been described. The ART is a questionnaire administered to an audience after a performance – it collects qualitative and quantitative emotional and cognitive reactions in written form. It is an ideal instrument for the recording of detailed explicit, verbal responses and is the only method available for recording individual interpretations of a work. The measurement of eye movements is a complementary technique that gathers moment-to-moment responding; it is non-verbal and suited to dance film and other recorded events. Measures such as eye movements have the advantage of being implicit, indirect, and returning time-series data that can be compared with the structure, activity, and form of the unfolding piece. Importantly, the choice of research method will be determined by the form of knowledge to be elicited, then described and/or quantified, to answer a particular question.

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http://www.ausdance.org.au/unspoken;
http://www.ausdance.org.au/connections;
http://marcs.uws.edu.au and search 'intention'.

Notes

[i] *F* refers to the statistical output of the analysis of variance.

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