AHRC ICT Methods Network Workshop – De Montfort Univ./Leicester 12 June 2007
New Protocols in Electroacoustic Music Analysis

Three Techniques for Measuring Audience Reactions

Catherine Stevens[1] with Shirley McKechnie[2], Renee Glass[1], Emery Schubert[3], Johnson Chen[1],

Heather Winskel[1], Sue Healey and Mark Gordon[4]

[1]School of Psychology and MARCS Auditory Laboratories
University of Western Sydney, NSW, Australia

[2]School of Dance, Victorian College of the Arts

[3]University of New South Wales

[4]The Australian Choreographic Centre

RUNNING HEAD: Measuring Audience Reactions

Word count: 2279 (text), 610 (references)

Address for correspondence:
Catherine Stevens
MARCS Auditory Laboratories
University of Western Sydney - Bankstown
Locked Bag 1797
South Penrith DC NSW 1797 Australia
Email: kj.stevens@uws.edu.au
Phone: (+612) 9772 6324
Fax: (+612) 9772 6040
Internet: http://marcs.uws.edu.au/

Three Techniques for Measuring Audience Reactions

This paper sketches some of the goals and achievements of an interdisciplinary research project *Conceiving Connections: Increasing Industry Viability through Analysis of Audience Responses to Dance Performance* led by Professor Shirley McKechnie from the School of Dance at the Victorian College of the Arts. As the experimental cognitive psychologist on the *Conceiving Connections* research team my role, with doctoral student Renee Glass, was to develop new methods to measure psychological responses – cognitive, emotional and affective – to live performance of contemporary dance. By contemporary dance we mean an artform where the major medium is movement, deliberately and systematically cultivated for its own sake, with the aim of achieving a work of art (Grove, Stevens & McKechnie, 2005).

The motivation for this industry-funded project was for the development of greater audience interest in Australian contemporary dance. As psychologists, we began by asking to what extent do Australian audience members –those experienced and those less experienced with contemporary dance – react and respond to contemporary dance? The long-term goal was to gain insights into the psychological responses of audience members with a view to enhancing and developing audience enjoyment and response to dance as well as understanding the cognitive processes that underlie the dance observing audience experience (such as aesethetic, affective and formal experiences). Here we provide an outline of three new techniques that we have applied to gauge psychological responses to Australian contemporary dance. The methods are equally applicable to the investigation of perceptual and psychological responses to live or recorded performance of other artforms such as music, drama, cinema, new media, and multimedia.

A New Psychometric Instrument for Measuring Audience Reactions: The Audience Response Tool (ART)

An experimental approach was taken to investigate audience response to dance. This involved the systematic manipulation of three independent variables, choreographic intention (representational versus abstract), audience member expertise (experts versus novices)[1], 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 experimental testing 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 the Australian Capital Territory (Canberra), New South Wales (Sydney), Tasmania (Launceston), and Victoria (Melbourne and Geelong). Approximately half of each audience arrived early to receive either a generic or specific information session about the work they were about to see. The sessions were presented by 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 or comparison condition for the information variable (i.e. the control group receive no information other than the title of the work and brief program notes). The two dance works were *Red Rain* choreographed by Anna Smith (for an account of the choreographic creation and development of *Red Rain* see Stevens, Malloch, McKechnie & Steven, 2003) and *Fine Line Terrain* choreographed by Sue Healey (for an account of the choreographic creation and development of *Fine Line Terrain,* see Healey, 2005).

The Audience Response Tool (ART) constructed by Renee Glass is a new psychometric

[1] Audience members with more than 10 years training in contemporary dance were classified as experts. Audience members who had not received training in dance and who had not observed contemporary dance prior to the testing session were classified as novices.

instrument for gathering cognitive, emotional and affective reactions to live or recorded performance. 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 (e.g., age, gender, dance or music experience, etc.) section.

Exhaustive qualitative and quantitative analyses of open-ended responses conducted by Glass (2006) demonstrated that approximately 90% of participants formed an interpretation of the dance work that they saw. 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; 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; specific information sessions did impact on the *content* of interpreted responses.

Almost 90% of participants reported that they felt an emotional response, and almost 95% of participants reported that they enjoyed at least one aspect of the dance-work. 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 (Glass, 2005, 2006). Information sessions did not impact on the tendency to respond emotionally or the tendency to enjoy the piece. Differing levels of dance expertise and experience amongst audience members

did not appear to affect verbal responses gathered using the ART. Implications of the study, briefly, include the value of a period of reflection after a performance suggested by the enthusiasm with which people entered into completing the questionnaire, and the role of pre-performance sessions offering a variety of different possible ways to interpret or consider aspects of a live performance.

Measuring Continuous, On-Line Responses to Performance – The Portable Audience Response Facility (ARF)

To capture reactions from audience members as a performance unfolds, a PDA-based portable Audience Response Facility (ARF) has been designed in MARCS Auditory Labs to record 1- or 2-dimensional data continuously, sampling twice per second. The portable ARF supplements the ART in that the former is on-line, discrete but continuous rather than retrospective, and programmable to record a range of different measures. One-dimensional measures that can be recorded continuously using the ARF include complexity, engagement, or event activity. A popular two-dimensional measure derives from the dimensional model of emotions discussed by many researchers (e.g., Cowie, et al. 2000; Russell, 1980; Schubert, 2001). The 2D emotion-space (Schubert, 2001), for example, represents emotion labels in a two-dimensional, four-quadrant space constructed from the two dimensions arousal/activity (from low to high) and valence (from negative to positive). A two-dimensional representation of emotion space based on Cowie et al. (2000) is shown in Figure 1.

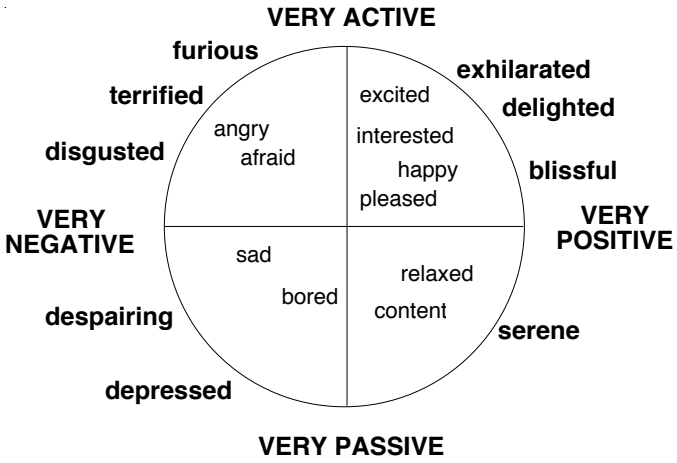

Figure 1. Interface for *FeelTrace* software for continuous measurement of 2D emotional response (Cowie, et al., 2000).

Small hand-held computers or PDAs have been custom-programmed (Stevens, Haszard Morris, Frear, Chen, Schubert, Glass, & Schoknecht, in preparation) to record from up to 20 audience members as a live (or recorded) performance of dance, music, theatre or new media unfolds. The PDAs are synchronized with the ARF server via Wi-Fi wireless network and with a recording of the live performance. The time series data – responses along, say, valence and arousal dimensions – are then scrutinized and interpreted in light of a structural description of the dance work (Figure 2), an analysis of the psychoacoustics of the soundscape, motion capture data recorded from the dancers during that performance (Stevens & McKechnnie, 2005b), patterns of approach and avoidance movement, or some other meaningful and predictive time series.

Physiological measures such as heart rate, breath rate or skin conductance may also be recorded concurrently and used to aid interpretation and/or validate affective reactions recorded using the portable ARF (e.g., Krumhansl, 1997). Analyses of electroacoustic and acousmatic music could be used to make predictions about changes in judged arousal and activity of the sound stimuli. Controlled experiments are needed to disentangle additive or multiplicative effects of auditory and visual modalities on audience response to music or dance. Such experiments are underway.

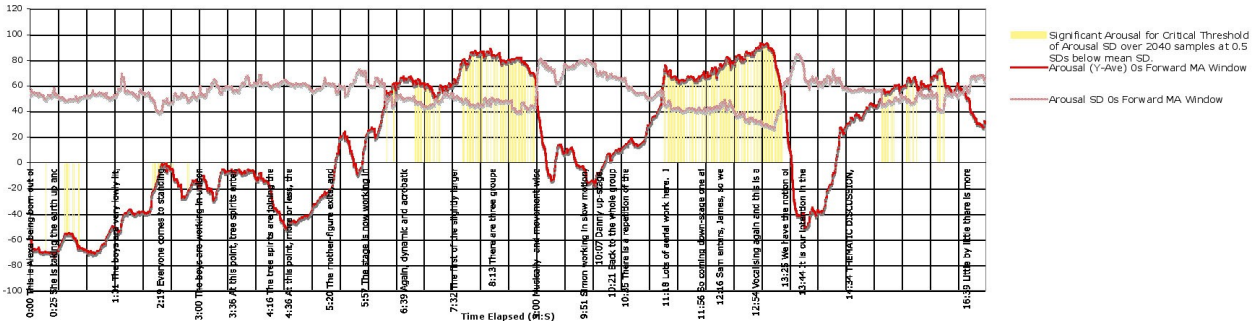

Figure 2. Mean arousal recorded during the opening sections of *Silent Heartbeat* (choreographer Albert David performed by the Quantum Leap Youth Choreographic Ensemble at the Canberra Playhouse Theatre, August 2006). The bold line shows mean arousal, averaged across a sample of 19 audience members. Mean arousal tends to increase over the course of the opening of the piece and relates to the surface features, intensity and tempo, of the dance and music. The fainter line shows the standard deviation or variability of response. Sudden decreases in judged arousal appear to follow dramatic changes or reduction in the soundscape and dancer activity. The shaded areas reflect areas of agreement between observers established from identifying those sections where the standard deviation is small and the second order deviation is small, suggesting that the mean is reliable, and used here as an indicator of audience agreement (Schubert, 2007). The text overlaid on the figure refers to an abbreviated structural description of the dance work.

Recording Eye Movements of Observers as an Indirect, Moment-to-Moment Index of Cognition

A final technique that we have applied to investigate more closely and analytically the effects of observer expertise on audience response to dance involves the recording of eye movements – eye fixations and saccades – as an index of on-line visual attention and cognitive processing. This technique has further advantages over the ART and portable ARF in that the recorded response is neither verbally-mediated nor necessarily voluntary or conscious.

Researchers have found evidence of eye movement pattern differences between novice and expert visual engagement using typical field-linked tasks. Attention and perception immediately engage via pertinent highly elaborated and coded constructs (schemas). For example, the eye movements of good readers relative to poor readers are characterized by shorter fixations, longer saccades, and fewer regressions (Jared et al. 1999; Rayner 1998). Expert chess players, relative to intermediate players, display fewer fixations per trial, greater saccade amplitude, tend to fixate empty squares and/or relevant pieces (Charness et al. 2001). Novice pilots dwell nearly twice as long as experts on the information-rich attitude directional

indicator, requiring more time to extract difficult information (Bellenkes et al. 1997) and novice drivers record longer head-down dwells than experts (Wikman et al. 1998).

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 parafoveal and peripheral processing. Movement in the periphery will prompt saccades (Fitzpatrick, 1990). Like chess experts, it is likely that dance experts have access to knowledge in long-term memory of dance schemata or expectancies that guide visual perception and interpretation. Perception will be rapid, encoding large clusters of related information or chunks. Knowledge in long-term memory acquired from experience with the artform will guide this perceptual organization and chunking. Chunking of information will maximize the capacity and executive efficiency of short-term memory. Expectancies will guide eye movements to locate the most relevant areas on which to focus attention. Accordingly, we hypothesize that fixation durations recorded by expert observers will be shorter than those of novice observers.

Eye movements were recorded from eight observers – four experts and four novices – as they watched a five-minute dance film *13 and 32* choreographed by Sue Healey. The observers each viewed the film twice. An EyeLinkII video-based pupil monitoring system recorded observer eye movements (Stevens et al. 2007).

As hypothesized, fixation durations of experts were significantly shorter than those of novices, $F(1,246)=6.91$, $p<0.05$, see Figure 3. 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 durations during the first viewing of the film relative to the second viewing (Fig. 3). Overall fixation durations 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), $F(1,246)=5.04$, $p<0.05$.

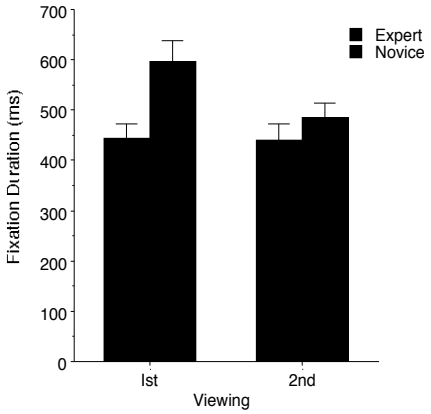

Figure 3. Fixation duration (ms) as a function of expertise and viewing session.

These patterns of eye movements allow us to infer specialized attention, chunking and expectancy processes. The shorter fixation durations of experts suggest rapid perceptual processing guided by expectancies and schemata in long-term memory. Like highly skilled readers, pilots, and drivers, dance experts make relatively short fixation dwells as they are adept at abstracting and extracting key information from complex movement material. Knowledge of dance in general and different choreographic styles in particular enabled efficient chunking of information that, in turn, maximized capacity of short-term memory. The significance of these results lies in the way moment-to-moment cognitive processes have been captured in response to a dynamic, non-verbal, yet communicative, artform. Eye movements provided an indirect measure of rapid cognitive processes without the need for verbalisation. Future analyses will scrutinize effects of expertise and specialist knowledge on regions of fixation, saccadic amplitude, and anticipatory eye movements.

Conclusion

A range of measurement techniques is available to elicit and record psychological responses of audience members. These may be administered under controlled conditions with the systematic manipulation of two to three independent variables of interest. Dependent measures include pen and paper methods that yield open-ended (qualitative) and/or rating scale (quantitative) data. Qualitative data are beneficial in driving and refining rating scale items (Glass, 2006). A questionnaire format yields rich data although it requires a retrospective, average response that is verbal in nature. Some responses to works of art of course will not be available to conscious awareness or able to be declared in verbal form (Stevens & McKechnie, 2005a; Stevens, Malloch & McKechnie, 2001). For this reason, we have developed the portable Audience Response Facility (ARF). The hand-held, computerised ARF yields continuous data along one or two dimensions and invites interpretation in light of other time series data such as psychoacoustics, movement velocity captured with motion tracking tools, and/or physiological responses heart rate, breath rate, and skin conductance. Finally, we have demonstrated that eye fixations provide an index of rapid, moment-to-moment attentional processes as a pre-recorded performance unfolds.

Acknowledgments

This research was supported by Australian Research Council Linkage grants (LP0211991, LP0562687, LE0347784) in collaboration with industry partners the Australia Council for the Arts, The Australian Choreographic Centre, the Australian Dance Council –Ausdance, the ACT Cultural Facilities Corporation and Canberra Playhouse Theatre, and a research grant from the University of Western Sydney. The performances and research projects reported here would not have been possible without expertise, advice, and assistance received from: Robin Grove, Anna Smith, Ruth Osborne, Stephen Malloch, The Quantum Leap Youth Choreographic Ensemble, Albert David, Rua Haszard Morris, Matt Frear, Colin Schoknecht, Clare Howell, Josephine Milne-Home and Cyril Latimer.

Author Note

Detailed manuscripts reporting each of the three studies described here are in preparation by Renee Glass, Catherine Stevens, and collaborators. For further information, contact Catherine (Kate) Stevens: kj.stevens@uws.edu.au; websites: http://www.ausdance.org.au/connections/, http://choreocentre.org.au/, and http://marcs.uws.edu.au.

References

Bellenkes, A. H., Wickens, C. D., & Kramer, A. F. (1997). Visual scanning and pilot expertise: the role of attentional flexibility and mental model development. *Aviation, Space, and Environmental Medicine, 68,* 569-579.

Charness, N., Reingold, E. M., Pomplun, M., & Stampe, D. M. (2001). The perceptual aspect of skilled performance in chess: evidence from eye movements. *Memory & Cognition, 29,* 1146-1152.

Cowie, R., Douglas-Cowie, E., Savvidou, S., McMahon, E., Sawey, M., & Schroeder, M. (2000) FEELTRACE: an instrument for recording perceived emotion in real time In R. Cowie, E Douglas-Cowie & M. Schroeder (eds) *Speech and Emotion: Proceedings of the ISCA workshop* (pp 19-24). Newcastle, Co. Down.

Fitzpatrick, T. (1990). Models of visual and auditory interaction in performance. *Gestos, 9,* 9-22.

Glass, R. (2005). Observer response to contemporary dance. In Grove, R., Stevens, C. & McKechnie, S (Eds.). *Thinking in four dimensions: Creativity and cognition in contemporary dance* (pp. 107-121). Carlton: Melbourne University Press.

Glass, R. (2006). *The Audience Response Tool (A.R.T.): The impact of choreographic intention, information and dance expertise on psychological reactions to contemporary dance.* Unpublished doctoral dissertation, MARCS Auditory Laboratories, University of Western Sydney.

Grove, R., Stevens, C., & McKechnie. S. (Eds.). (2005). *Thinking in four dimensions: Creativity and cognition in contemporary dance.* Carlton: Melbourne University Press.

Healey, S. (2005). Navigating fine lines. In Grove, R., Stevens, C. & McKechnie, S (Eds.). *Thinking in four dimensions: Creativity and cognition in contemporary dance* (pp. 57-80). Carlton: Melbourne University Press.

Jared, D., Levy, B. A., Rayner, K. (1999). The role of phonology in the activation of word meanings during reading: Evidence from proofreading and eye movements. *Journal of Experimental Psychology: General, 128,* 219-64.

Krumhansl, C. L. (1997). An exploratory study of musical emotions and psychophysiology. *Canadian Journal of Experimental Psychology, 51*, 336-53.

Rayner, K. (1998). Eye movements in reading and information processing: 20 years of research. *Psychological Bulletin, 124*, 372-422.

Russell, J. A. (1980). A circumplex model of affect.*Journal of Personality and Social Psychology, 39,* 1161–1178.

Schubert, E. (2001). Continuous measurement of self-report emotional response to music. In P. Juslin and J. Sloboda (Eds.), *Music and Emotion: Theory and Research* (pp. 393-414). Oxford University Press.

Schubert, E. (2007). When is an event in a time series significant? *Proceedings of the International Conference on Music Communication Science (ICoMCS)*. Sydney, December.

Stevens, C., Haszard Morris, R., Frear, M., Chen, J., Schubert, E., Glass, R., & Schoknecht, C. The Audience Response Facility (ARF): a portable device for synchronized, on-line recording of continuous data during live performance. Manuscript in preparation

Stevens, C., & McKechnie, S. (2005a). Thinking in action: Thought made visible in contemporary dance. *Cognitive Processing, 6,* 243-252.

Stevens, C., & McKechnie, S. (2005b). Minds and motion: Dynamical systems in choreography, creativity, and dance. In J. Birringer & J. Fenger (Eds.) *Tanz im Kopf: Yearbook 15 of the German Dance Research Society, 2004*(pp. 241-252). Münster: LIT Verlag.

Stevens, C., Malloch, S., & McKechnie, S. (2001). Moving mind: The cognitive psychology of contemporary dance. *Brolga: An Australian Journal About Dance,* December, 55-67.

Stevens, C., Malloch, S., McKechnie, S., & Steven, N. (2003). Choreographic cognition: The time-course and phenomenology of creating a dance. *Pragmatics & Cognition,* 11, 299-329.

Stevens, C., Winskel, H., Healey, S., Howell, C., Vidal, L-M., Latimer, C., & Milne-Home, J. (2007). The dancing brain: The effect of expertise on visual attention while viewing Australian contemporary dance. In *Proceedings of the International Association of Dance Medicine & Science Conference,* Canberra, Australia.

Wikman, A-S., Nieminen, T., & Summala, H. (1998). Driving experience and time-sharing during in-car tasks on roads of different width. *Ergonomics, 41,* 358-372.