Examining the Spectator Experience

A. Cavan Fyans
Queen's University Belfast

Examining the Spectator Experience

A. Cavan Fyans, Michael Gurevich, Paul Stapleton
Sonic Arts Research Centre
Queen's University Belfast
BT7 1NN, UK
{afyans01, m.gurevich, p.stapleton}@qub.ac.uk

ABSTRACT

Drawing on a model of spectator understanding of error in performance in the literature, we document a qualitative experiment that explores the relationships between domain knowledge, mental models, intention and error recognition by spectators of performances with electronic instruments. Participants saw two performances with contrasting instruments, with controls on their mental model and understanding of intention. Based on data from a subsequent structured interview, we identify themes in participants' judgements and understanding of performance and explanations of their spectator experience. These reveal both elements of similarity and difference between the two performances, instruments and between domain knowledge groups. From these, we suggest and discuss implications for the design of novel performative interactions with technology.

Keywords

Spectator, error, mental model, intention, qualitative

1. INTRODUCTION

This paper presents a qualitative study that explores the relationship between elements of a model of spectator understanding of error in performance [3]. This model was developed as a part of a larger project studying the role of the spectator in the greater ecology of performance with electronic instruments. The model details how a spectator forms an understanding of error between a performer and an interactive electronic system during performative interactions. The model was further discussed in the specific context of NIME [4], in relationship to central issues of the field such as transparency, mapping and skill. It was proposed that rather than transparency, a more useful method for examining the understanding of interaction is to investigate the spectator's mental model. Furthermore, the spectator's mental model, understanding of intention and understanding of error in performance were presented as primary factors in assessments of skill and success [4].

In the following sections a qualitative experiment protocol is detailed, results are presented and conclusions are drawn from the data. There were two primary hypotheses in the experiment: **1)** Participants with a more accurate mental model of the performative interaction will have a more accurate understanding of error in performance. **2)** Participants with a more accurate understanding of the performer's intention will display a more accurate understanding of error in performance.

NIME2010, 15-18th June 2010, Sydney, Australia

2. METHOD

2.1 Participants

Twenty-seven participants were selected: 23 males and 4 females with an age range of 19-35 years. Because the experiment used a between-subjects design, participants were chosen with a wide range of knowledge in areas we expected would affect their understanding of interaction and performance. This ensured that the effects of participants' domain knowledge could be tested alongside the other elements of the model. We considered three areas that constitute domain knowledge: **Acoustic music and performance** (non-instrumental musical training, acoustic instruments played, length of time played and expertise, non-musical performance training, attendance of live acoustic music), **electronic/computer music and electronic instruments** (training in computer music and electronic instruments, electronic instruments played, length of time played and expertise, knowledge of electronic instruments, attendance of live electronic music) and **interactive electronic devices, engineering, design and HCI** (training in engineering and design, expertise in interactive devices, use of interactive devices, facility with new interactive electronic devices). Participants' experience ranged from no knowledge in any form of music or electronic devices through undergraduate music students to PhD researchers in interaction design and new electronic instruments.

An online questionnaire was developed to assess each potential participant's levels of domain knowledge in these areas. The questionnaire primarily utilised clearly defined Guttman scales according to which participants self-assessed their degrees of knowledge or experience. This quantitative data was further supported by questions requiring the participants to qualify their previous answers. To assess each participant's level of domain knowledge, all of the quantifiable data points in each of the three knowledge areas were summed, yielding three scores per participant. These scores ranged from 4 to 24. Each participant's overall domain knowledge score was calculated as a weighted average of these three scores, with the score for electronic/computer music and electronic instruments double-weighted, as it was deemed to be the central knowledge area. Participants domain knowledge scores were between 5 and 32. Participants were then divided into three equal groups of equal size; the nine lowest scores in one, the nine highest in another and the remaining nine in the third. These were low, high and medium domain knowledge groups respectively.

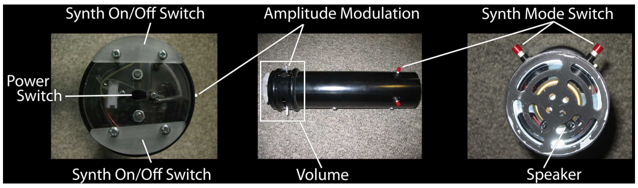

Figure 1: The Tilt-Synth

2.2 Controls

The experiment was centered around two video performances. **Video 1**, a solo Theremin performance of a 2 minute composition in Rondo form, featured three repetitions of a theme interspersed with two contrasting improvisations. This was performed by a musician with training and experience in guitar, electric bass and percussion. The performer had no previous experience with the Theremin. Performing with the instrument for the first time, he recorded the video performance after approximately thirty minutes of practice. This performance's primary purpose was to isolate the effects of the participants' understanding of intention. The Theremin was selected in order to ensure all participants had a highly accurate mental model of the performative interaction. The Theremin would be well known to participants with higher levels of domain knowledge. It is also an instrument in which the translation of performer-gesture to sound is self-evident, enabling participants who had no mental model of the Theremin to quickly form an accurate mental model. To ensure all participants' mental models were accurate, the performer prefaced the performance with a short demonstration of the Theremin, explaining the interaction and demonstrating the ranges and limits of the controls. In order to control participants' understanding of intention, the performer also recorded two introductions that would also precede the performance: One explaining the structure of the piece he was about to perform and the second incorrectly explaining the structure of piece he was about to perform.

Video 2 was primarily used to isolate the effects of the accuracy of the participants' mental model of the performative interaction. To ensure that no one had pre-existing knowledge of the instrument, a novel electronic instrument, the Tilt-Synth (**Figure 1**), was developed especially for the experiment. The instrument was designed to combine large, obvious, physical gestures with fine-grained controls. Similarly, it utilised both simple one-to-one gesture-to-sound translations and mode switching to more complex ones. The Tilt-Synth was additionally designed such that its operation occupies the majority of the performer's attention. This promoted the communication of intentionality in all of the performer's manual actions and minimised the ambiguity of address [2]. The Tilt-Synth is a standalone unit consisting of a small (25cm long x 7cm dia) cylindrical tube with tactile discrete controls located near the ends of the unit, a two axis accelerometer in the centre and the loudspeaker inside one end. The sensors are monitored by an Arduino Nano[1] micro-controller, which is also responsible for synthesis of two square wave tones. The discrete excitation gesture is controlled with a switch operated by one hand placed on one end of the tube and continuous parametric modification gestures with the other. Two sliders near the excitation end of the instrument continuously control amplitude modulation. Two additional discrete, tactile switches located near the speaker end of the instrument toggle the synthesis mode between distinct pitches and pseudo-noise generation. In pitch mode, the pitch of each oscillator is controlled by the tilt angle of the instrument on two axes providing gestural spatial control. In noise mode, the same gestures control the noise bandwidths. The Tilt-Synth performer was selected due to experience performing with similar electronic instruments. The performer has a PhD in composition with experience playing guitar, cello, piano and sensor-based electronic music systems. He had roughly two hours of practice with the Tilt-Synth before the performance was recorded.

Similar to Video 1, the performance consisted of a 2-minute composition in Rondo form with three repetitions of a theme separated by two contrasting improvisations. Although the performances in both videos followed the same general form, the content of the themes and character of the improvisations were quite different (only two participants commented on any perceived similarity between the compositions). The performer in Video 2 also recorded two introductions to the performance. One accurately demonstrated the Tilt-Synth's ranges of controls, gesture-to-sound mappings and technical design. The second explained the instrument incorrectly. These two prefaces to the performance were used to control the accuracy of participants' mental models.

Participants were divided into three groups of 9 participants. Each consisting of 3 low, 3 mid & 3 high domain knowledge scores. Groups were allocated videos as follows: **Group A:** Theremin demonstration, Theremin performance, Tilt-Synth performance. **Group B:** Theremin demonstration, correct Theremin piece explanation, Theremin performance, correct Tilt-Synth demonstration, Tilt-Synth Performance. **Group C:** Theremin demonstration, incorrect Theremin piece explanation, Theremin performance, incorrect Tilt-Synth demonstration, Tilt-Synth Performance.

2.3 Data collection & Analysis

Prior to the experiment, participants were given no information on the focus of the study or the direction of the structured interviews. This ensured that attention and perception were not affected during the experiment. Each participant was presented with the video introductions and performances specific to their group and only shown each video once. In the subsequent structured interview, the experimenter directed discussions around the following key points in relation to both performances, using a series of prepared questions and directed discussions: Emotional response, performer skill, expectation, mental models of the performative interactions, understanding of the performer's intentions, understanding of the result, understanding of error in performance, domain knowledge.

Each interview was videotaped for further analysis. Transcripts were prepared, annotated and indexed to the video using Transana.[2] Participants' accuracy of mental model and understanding of intention were coded on a scale between 0 (low) and 5 (high). Scores were assigned independently by the experimenters based on qualitative assessments of the participants' responses to specific questions and spontaneous comments during the interview. The independent scores agreed in roughly 75% of cases. The discrepancies were resolved through discussion among the study authors and further analysis of the transcripts.

3. OBSERVATIONS

Figure 2 shows the mean accuracy scores of each group's mental models of the two instruments and also their understanding of the performers intention for both performances. The mean values match our expectations from the video in-

[1]Arduino Nano micro-controller - http://www.arduino.cc

[2]Transana - http://www.transana.org/

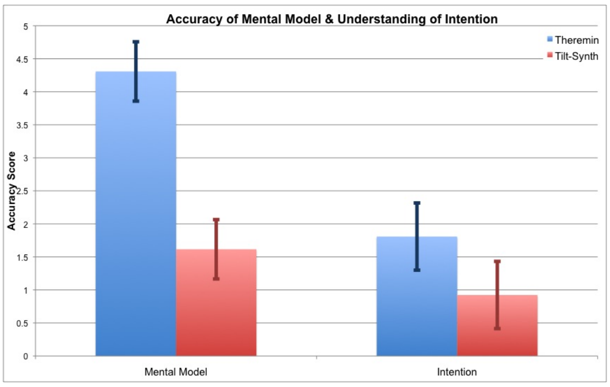

Figure 2: Accuracy of Mental Model & Intention

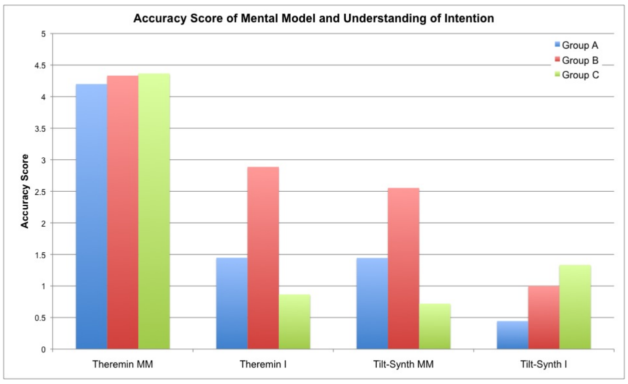

Figure 3: Accuracy Scores Per Group

troductions used to control participants' mental models and understanding of intention. However, with the exception of the Theremin mental models, the 95% confidence intervals for these results between groups A, B and C overlapped. For the majority of cases this is due to individual data points outlying in the relatively small sample of 9 participants.

3.1 Error

Only two participants identified errors in the Tilt-Synth performance, both of which were also noted as errors by the performer. Of the two, one described the error both in terms of the musical context and the physical actions they understood to be mapped to the sonic outcome: *"... pitch that was off at the end. I think it [the Tilt-Synth] was twisted around this way too much."* The other described it in terms of the performer's musical intentions, but was unsure if it was an error, *"If the [theme] he was using as the reoccurring motif was his intentions...it felt like that fell off in the end and became less important. It's not like it wasn't there, it just seemed to wander more towards the end."*

A much larger number of participants (n=9) were able to correctly identify one or more errors in the Theremin performance. Of these, seven highlighted a moment where the performer's hand accidentally struck the pitch antenna. Other errors tended to be described in musical terms; failure to reproduce pitch and rhythmic structures in repeated passages. Among these, one indicated that physical cues were as important in revealing errors as musical ones: *"There may have been a few times he went back and slightly missed the pitch and you can see him go back and kind of correct it."* In fact, physical cues were identified as important by five of the participants who didn't identify errors in either performance. According to one, *"you couldn't really tell by his facial expressions."* Another thought that the performer may have made errors, but was able to *"cover it up."* Another participant initially thought he had seen an error, based on physical cues, but was subsequently unable to locate it even after reviewing the video: *"I do think there was [an error], but I can't remember what it was. At one point something happened that he was taken aback by or it didn't seem to fit, but I can't remember what it was."*

The difference in overall averages of mental model accuracy and of understanding of intention between the Theremin and the Tilt-Synth suggests an explanation for the discrepancy in the ability of spectators to identify errors between the two performances. **Figure 2** shows that mean mental model score for the Theremin performance was 4.3, indicating that overall, participants had a much stronger understanding of how the instrument worked, than the Tilt-Synth, for which the mean score was just 1.6. **Figure 3** indicates that mental models were uniformly accurate across groups for the Theremin; the variance among all participants was only 0.38. The mental models for the Tilt-Synth had higher variance (1.37), this was expected according to the experiment design. There were so few errors identified with respect to the Tilt-Synth that correlations to mental model accuracy wouldn't be especially meaningful. However, we can say that on the whole, the inability to identify errors absent an accurate mental model was significant. As with the mental model, the mean score for understanding of intention was higher for the Theremin (1.8), relative to the Tilt-Synth (0.9). These data suggest that an accurate understanding of intention also facilitates the ability to identify errors. Of the participants who did identify errors in the Theremin performance, 7 of 9 were in the highest domain knowledge group, indicating that domain knowledge is also an important factor in understanding of error. Although the number of errors identified by participants was lower than expected, this data largely confirms our hypotheses as to the influence of domain knowledge, mental model and understanding of intention on error understanding.

The data was re-examined for indications of why there was widespread inability to identify errors. Four important themes emerged. The first relates specifically to the previous observation about understanding of intention. For the Tilt-Synth performance, 9 participants discussed their non-identification of error in terms of intention or expectation. Four of these mentioned a lack of understanding of what the performer was trying to do, or of what to expect from the performance. One noted, *"I didn't think there were many mistakes. It's hard to tell what's intentional and what isn't."* Interestingly, this participant went on to say that in this circumstance, he relied on gestural cues: *"Looking at the body language there wasn't anything like 'oh I goofed.'"* This participant also had one of the lowest scores for mental model accuracy for this instrument.

Five other participants thought there were no errors because the performer had achieved his intentions, however most also seemed to rely on gestural cues to formulate this assessment. One characteristic comment was, *"There was no sign at all that he made a mistake and he looked like he did what he set out to do."* Several participants described a sense of confidence that arose from the performer's perceived expertise, which was also communicated physically. After finding no errors, one of these participants said, *"There was something about his quality of playing that he knew what the instrument did. Even though I don't understand fully what the instrument was doing, I could see his control of the instrument was precise, he wasn't like 'oh what does this do?' You can see that in the person's body when they don't really know what to do. I could see he knew* *what to do with it. There was a physical confidence."*

Several participants (Theremin n=4; Tilt-Synth n=6) suggested that the reason they could not recognise errors in performance was because it was impossible for the performer to make an error. This was due to a perceived improvisatory nature of the performance, in spite of its well-defined form. One commented on a perceived lack of predefined structure in the Theremin performance: *"When you talk about improvised performance there's no mistakes, only good decisions and bad decisions."* Another participant said, *"No, I don't think it was a composed piece of music, I think they were making it up as they went along, so it's hard to make mistakes."* These notions focused both on a lack of discernible structure but also assumptions of 'these instruments' being specifically designed for improvisation. Although the perceived improvisatory nature of the performance was partly accurate, the performer clearly stated he had made mistakes during both the composed theme and the improvisation.

Similarly, during discussions of error in the Tilt-Synth performance, participants explained their inability to find errors due to a perceived inability for the performer to make errors. Participants explained this as a result of the perceived indeterminate nature of the Tilt-Synth. Many participants (n=6) thought that the instrument had inbuilt randomness or that it may suddenly and drastically change the sound being produced. They perceived that the performer therefore could not make a mistake, as sonic 'errors' were part of the instrument. One noted, *"He is playing a lot with the randomness of it, within that randomness it's not really right or wrong, its just things happening. Some things happened, which could be seen as mistakes, but are part of the instrument."* Another said, *"I assume it's more improvisatory, that it's not so much a mistake, it's kind of open to the fact that the soundscape could change drastically."*

4. EVALUATION OF METHODOLOGY

The methods used to control the participants' understanding of the performer's intention produced mixed results. **Figure 2** shows the control of the participants' mental model of the Theremin was accurate. However, our ability to control accuracy of participants' understanding of intention was limited. Participants in Group B would have ideally demonstrated a more accurate understanding of intention given the performer's explanation of the piece. However, participants' accuracy scores in Group B were distributed evenly from 1 to 5. Likewise, participants in Group C were expected to have lower scores in accuracy of understanding of intention, as they were given an incorrect explanation of the piece. Group C did show mostly low scores but the difference from Group B was not significant.

We suggest that the limited ability to control the participants' understanding of intention is related to assumptions of electronic music and improvisation. Seventeen participants perceived the Tilt-Synth performance to be entirely improvised, in spite of the composition containing a clear repeated theme. The basis for the method of controlling participant's understanding of intention was derived from literature on perception of action and intention. It is accepted that the understanding of specific action sequences is driven by the understanding of greater structures of intention [1]. In explaining the intentions behind the Theremin performance in musical terms, participants without musical domain knowledge were unable to relate the greater structure to sequences of intentional actions, one stated, *"He was doing two improvisations, I assume what he was calling improvisations were like a type of rhythm or something he was doing."*

5. IMPLICATIONS AND FUTURE WORK

The results indicate that spectators who are unable to form an accurate understanding of a performative interaction rely on facial expression and gestural information in order to make judgements of performance errors. The results also show a strong trend towards assumed connections between electronic instruments, improvised performance and 'error-free' instruments, even displayed by participants with higher levels of domain knowledge. We suggest that the interface or instrument with which the performer is interacting could make errors in performance more explicit in order to improve spectator's understanding. However, this information should be implicit within the system [7], in much the same manner that facial and bodily gestures are an implicit feature of performance. This presents a challenge in designing systems that 'reveal' error but without explicitly directing spectators' attention toward it.

In this study, we gathered data on emotional responses to the performances. From them, one important observation has emerged that relates strongly to the data presented in this paper. Several participants (Theremin n=3; Tilt-Synth n=4) voluntarily highlighted the fact that they enjoyed the performances more because the performer explained the instrument first. They commented that it helped them understand the interaction and performance. This can be directly related to research showing that positively valenced emotional responses result from fulfilment of correct expectations [6]. As it is not always viable to explain a novel performance system to a spectator in advance, this suggests that the degree to which a spectator gains an understanding of new interactions needs to be addressed through interaction design. We anecdotally associate this with an observed practice in live coding, where performers provide a 'running commentary' of their actions in typed comments in order to facilitate the understanding of spectators not familiar with the programming language. However with physical interactions, we do not always have the luxury of making this communication explicit. We therefore need to identify ways of facilitating similar understanding through the substance of the interaction, which includes the design of an instrument, composition and performance. This further relates to Gurevich, Stapleton and Bennett's [5] emphasis on discernment of structure in new interactions.

6. REFERENCES

[1] D. A. Baldwin and J. A. Baird. Discerning intentions in dynamic human action. *Trends Cogn. Sci.*, 5(4):171–178, 2001.

[2] V. Bellotti, M. Back, and W. K. Edwards. Making sense of sensing systems: five questions for designers and researchers. In *Proc. CHI*, pages 415–422, 2002.

[3] A. C. Fyans, M. Gurevich, and P. Stapleton. Spectator understanding of error in performance. In *CHI Extended Abstracts*, 2009.

[4] A. C. Fyans, M. Gurevich, and P. Stapleton. Where did it all go wrong? A model of error from the spectator's perspective. In *Proc. of the Conf. on New Instruments for Musical Expression (NIME)*, 2009.

[5] M. Gurevich, P. Stapleton, and P. Bennett. Designing for style in new musical interactions. In *Proc. of the Conf. on New Instruments for Musical Expression (NIME)*, 2008.

[6] D. Huron. *Sweet Anticipation: Music and the Psychology of Expectation*. The MIT Press, 2006.

[7] A. Schmidt. Implicit human computer interaction through context. *Personal and Ubiquitous Computing*, 4(2):191–199, 2000.