We can work it out: towards a participatory approach to designing music interactions

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In domains such as music, the ability to effectively engage in a variety of activities is often dependent on knowledge of domain-specific theories, terminologies, concepts and processes learned in an academic context and made implicit through repeated practice. For activities of this nature, creating or enhancing software-based interaction designs to support novice users can be a challenging undertaking. One promising approach to this challenge involves decoding musicians’ implicit domain knowledge into structures known as conceptual metaphors, metaphorical extensions of recurring embodied experiences applied to abstract domains, and using this information to inform subsequent Music Interaction designs. In this paper we propose a participatory approach to Music Interaction design, intended to produce interaction designs for music software that are more “intuitive” in a precise sense, based on the principles of Conceptual Metaphor Theory.

Music Interaction design, embodiment, conceptual metaphors, image schemas, participatory design

1. INTRODUCTION

Music is an integral component of our daily lives, providing a medium for communicating emotions and ideas as well as expressing more trivial information such as the result of an interaction with computer software, for example sonifying the movement of a file to the trash or the receipt of a new email. Pervasive and popular though music is, the ability for novices to effectively participate in tasks involving structural understanding and creation of musical artifacts is often hindered by a lack of knowledge of the theories, terminologies, concepts and processes used in the domain. Such knowledge is often learned within an academic context and made implicit through repeated practice, as a result restricting technical understanding of music to highly trained domain experts. The understanding of concepts such as voice leading, harmonic progression and rhythm in particular are vital to the structural comprehension of many categories of musical artifacts but conversely difficult to discuss without the use of domain-specific terminologies and notations. Similarly, representing such concepts and relationships in Music Interaction designs within music software without excluding users who lack this domain knowledge can be a challenging undertaking. We hypothesise that if we can represent this knowledge in a form that exploits pre-existing and universally held sensory-motor experiences, we will be able to lower some of the barriers to structural understanding of musical artifacts, lessening the requirement for specialist domain knowledge and resulting in Music Interaction designs that are more intuitive to both domain experts and novices alike.

A promising foundation for this work can be found in the identification of constructs named image schemas, defined as “recurring patterns of our sensory-motor experience” (Johnson 2005). Image schemas, it is argued, form the basis of our understanding of abstract concepts through their application to other domains, creating conceptual metaphors (Johnson 2005). A number of recent studies applying image schema and conceptual metaphor theories to interaction design (Hurtienne and Blessing 2007; Hurtienne, Israel and Weber 2008; Treglown 1999), music theory (Saslaw 1996, 1997; Zbikowski 1997a, 1997b; Brower 2000; Larson 1997; Johnson 1997; Johnson and Larson 2003; Eitan and Granot 2006; Eitan and Timmers 2010), sound interaction design (Antle, Droumeva and Corness 2008; Antle, Corness and Droumeva 2009) and Music Interaction evaluation (Wilkie, Holland and Mulholland 2009, 2010) have produced encouraging results, highlighting the potential of these theories as a basis for a
methodology for Music Interaction design and evaluation.

In this paper we present a methodology for designing Music Interactions for music software primarily aimed at novice users in collaboration with musical experts, using Conceptual Metaphor Theory to drive participatory design sessions.

2. EMBODIED UNDERSTANDING

Research into the development of conceptual models has posited the theory that our understanding of abstract concepts such as melody, harmony and rhythm are grounded in repeating patterns of our sensory-motor experiences of space, orientation, forces and interactions with other bodies in our environment (Saslaw 1996; Zbikowski 1997a, 1997b; Brower 2000; Lakoff and Nuñez 2000; Johnson 2005; Rohrer 2005, 2007). These repeating patterns named image schemas are typically identified through the analysis of linguistic expressions. For example, the experience of one object being contained by another can be referred to both literally in phrases such as “put the toys in the box” and metaphorically in phrases such as “the melody is in the key of F”. In both cases, the use of the CONTAINER image schema is indicated through the use of the preposition “in”. However, in the second example the container object, the key of F, is an abstraction rather than a tangible entity.

The inherent structure of the CONTAINER image schema gives rise to a series of entailments that can be used to carry out spatial reasoning operations. As Figure 1 below demonstrates, if an object is inside a container and that container is itself inside another container, then the object is by definition inside both containers.

![Figure 1 Representation of the relationships between OBJECTS and nested CONTAINERS](image)

Through mapping these image schemas onto the corresponding aspects of a target domain creating conceptual metaphors, we can structure our understanding of abstract concepts such as harmonic progressions (Lakoff and Nuñez 2000; Johnson 2005). For example, analysis of the seemingly simple phrase “the melody starts in C and moves up to G”, reveals a number of metaphorical mappings as listed below.

(i) The CONTAINER image schema has been mapped onto the target domain of key, resulting in the conceptual metaphor A KEY IS A CONTAINER FOR MELODY.
(ii) The UP-DOWN (sometimes referred to as VERTICALITY) image schema has been mapped onto the target domain of pitch, resulting in the conceptual metaphor HIGH PITCH IS UP/LOW PITCH IS DOWN.
(iii) The SOURCE-PATH-GOAL image schema has been mapped onto the target domain of melody, resulting in the conceptual metaphor MELODY IS MOVEMENT ALONG A PATH.

Furthermore, applying the principles of metaphorical entailment allows us to deduce that, based on the example above, G is higher than C, ignoring any octave context, and that the key of G is sounded after the key of C.

To ensure that the metaphorical mappings preserve the inherent structure of the image schemas that ground them, only applicable aspects of the source domain are mapped to the target domain, a process known as the Invariance Principle (Zbikowski 1997b). For example in the case of the conceptual metaphor MELODY IS MOVEMENT ALONG A PATH defined above, only the applicable aspects of the SOURCE-PATH-GOAL image schema are mapped onto the domain of melody, namely start and finish points and locations (which correspond to the notes within the melody). Although alternative mappings may exist, according to the Invariance Principle, a mapping’s success increases in relation to the number of image schematic correspondences between the source and target domains. As Zbikowski (1997b) notes, fruits do not readily map to pitches.

The ability to apply image schemas to other abstract domains through the process of metaphorical mapping makes them extremely useful for intuitive communication, informal reasoning and the analysis of conceptual models. The application of these theories to music theory, user interface and Sound Interaction design and Music Interaction evaluation will be discussed further in the sections below.

2.1 Embodied Understanding of Musical Concepts

Research into the application of image schema and conceptual metaphors theories to the domain of music to date has often focussed on analysing descriptions of various musical concepts and phenomena written by music theorists. For example Saslaw’s (1996) analysis of Riemann’s treatise “Systematic Study of Modulation as a
Foundation for the Study of Musical Form reveals Riemann’s use of CONTAINER and SOURCE-PATH-GOAL image schemas to describe the concepts of harmonic progression and modulation. Extending this analysis further, Brower (2000) applies the principles of Conceptual Metaphor Theory to the development of a cognitive theory of musical meaning, arguing that the image schemas most significant to our understanding of harmonic relationships and pitch resolution are CONTAINER, CYCLE, CENTRE-PERIPHERY, BALANCE and SOURCE-PATH-GOAL.

In a complementary study, Eitan and Granot (2006) investigated the associations between space and motion and changes in musical parameters such as pitch and tempo, asking participants to specify the movement of an imaginary character in response to musical stimuli. The results revealed that pitch descent was associated with spatial descent but that pitch ascent was only weakly associated with spatial ascent. This result is rather intriguing when we consider pitch is commonly mapped to height in Western culture through the use of the conceptual metaphor HIGH PITCH IS UP/LOW PITCH IS DOWN (Zbikowski 1997a, 1997b). Further work is therefore needed to establish the extent to which even widely accepted image schemas and conceptual metaphors are applied in practice.

### 2.2 Applying Image Schemas to User Interface Design

Although interaction designers are often advised to make use of metaphors to draw inferences between user interface designs and their everyday equivalent, the use of conceptual metaphors to drive user interface designs has received less attention. Treglown (1999) discusses the benefits of using the principles of Conceptual Metaphor Theory to refine the design of a basic file management system through the analysis of a text discussing management and organisation of paper files. His conclusion that the technique holds promise is echoed by Hurtienne and Blessing (2007). Arguing that a design could be considered intuitively usable if the user can subconsciously apply prior knowledge when interacting with the design, they explored the potential of using conceptual metaphors as a technique for developing more intuitive interaction designs. They designed simple user interfaces based on button and slider controls which either supported or contradicted basic conceptual metaphors such as MORE IS UP and GOOD IS UP. Participants were then asked to select the most appropriate button or move the slider in the appropriate direction based on their response to very simple phrases employing the conceptual metaphors under investigation. The results of the experiments were encouraging, indicating that, in general, configuring the button

and slider controls to support the conceptual metaphors under test led to a reduction in response times. However, as the experiments were limited to a small subset of conceptual metaphors and user interface controls, further work is required to give stronger support for their hypothesis.

In a contrasting study, Hurtienne, Israel and Weber (2008) investigated the potential of image schemas as a “meta-language” during the analysis and design phases of an invoice verification and posting system. They concluded that such an approach led them to focus more on the essential user interface requirements, adding further weight to the claim that these theories hold promise as a foundation for a methodology for interaction design.

### 2.3 Using Conceptual Metaphors to Design Sound Interactions

Investigating whether systems that employed embodied metaphors could be used effectively to manipulate simple parameters such as pitch, tempo and volume, Antle, Corness, and Droumeva (2009) and Antle, Droumeva, and Corness (2008) designed an interactive system that enabled users to manipulate sound parameters through bodily movement. These embodied metaphors were based on equating specific movements with changes in sound parameters, for example fast movement and fast tempo. Although the results of their experiments were inconclusive with respect to enhancing the ability of children to learn musical concepts, they did indicate that the system was easier to learn than an alternative version of the system using non-metaphor based mappings (Antle, Droumeva, and Corness 2008).

### 2.4 Evaluating Music Interactions Using Conceptual Metaphors

In earlier studies we demonstrated how conceptual metaphors could be used to evaluate existing Music Interaction designs within music software (Wilkie, Holland and Mulholland 2009, 2010). By analysing a transcript of a short dialogue between highly skilled and experienced musicians analysing a short excerpt of music, we were able to identify a number of conceptual metaphors, some of which were validated by previous studies such as Saslaw (1996), Zbikowski (1997a, 1997b), Eitan and Granot (2006), Eitan and Timmers (2010) and Brower (2000). These conceptual metaphors were then used to evaluate two examples of music software, Harmony Space (Holland 1994) and GarageBand (Apple 2009). By comparing the conceptual metaphors with aspects of the user interface including the layout, behaviour and configuration of the components we were able to identify instances where the user interface design supported or contradicted the conceptual
metaphors. In many cases the contradictions or tensions arose as a result of specific design decisions taken to enhance support for specific tasks; however some changes were made to Harmony Space based on the results of the evaluations such as the implementation of additional tracing features to support conceptual metaphors based on the SOURCE-PATH-GOAL image schema. The success of the evaluations provide increasing evidence of the claim that conceptual metaphors can be used as the foundation for a methodology for Music Interaction design and evaluation. The following sections explore a methodology for designing Music Interactions for music software primarily targeted at novice users.

3. DEVELOPING A PARTICIPATORY APPROACH TO MUSIC INTERACTION DESIGN

A participative approach to design highlights the importance of involving prospective users of the system in the design process (Preece, Rogers, Sharp, Benyon, Holland and Carey 1994). We propose that by conducting participatory design sessions with experienced musicians, driven by the conceptual metaphors identified in previous studies, we will be able to capitalise on musicians’ domain knowledge and subsequently develop Music Interaction designs for music software that are intuitively usable to novice users.

Although Conceptual Metaphor Theory has been used to inform new and redesign existing interactions (Antle, Corness, and Droumeva 2009; Antle, Droumeva, and Corness 2008; Hurtienne and Blessing 2007; Hurtienne, Israel and Weber 2008; Treglown 1999), to the best of our knowledge no studies have used Conceptual Metaphor Theory to specifically drive interaction design in collaboration with domain experts through the use of participatory design sessions. In the following sections we propose a methodology for such a task with respect to Music Interaction design.

3.1 Identifying and Validating Conceptual Metaphors

A valuable first step in such a methodology must necessarily be validating the conceptual metaphors already identified and providing opportunities to elicit further conceptual metaphors. These validated conceptual metaphors can then be used to provide materials to drive design discussions with musical experts and evaluate any resulting design decisions.

Further to the previous study with expert musicians, two further studies were carried out with a wider range of participants, all of whom played at least one musical instrument regularly, many also had experience of teaching, arranging, conducting and composition. In the first study participants were provided with a selection of words, and in a subsequent task, a set of basic images, and asked to use the words or images to describe and discuss short excerpts of music. In the second study participants were asked to bring along an excerpt of a piece of music they knew well and to discuss aspects of that excerpt such as harmony, rhythm and melody with other participants. A further task asking the participants to discuss a piece of music provided by the facilitator was also included.

Although the results of these studies are still being analysed, results so far indicate that a number of provisionally identified image schemas and their related conceptual metaphors can be validated. Additionally, the results so far suggest that although all the participants were skilled musicians, not all had the experience of analysing and discussing structural aspects of music to the level of detail that the participants in the earlier study had. This is a significant finding as it highlights the importance of engaging with participants with appropriate levels of expertise in the topics and tasks being discussed in order to ensure conceptual metaphors of a suitable conceptual depth are elicited. Otherwise superficial conceptual metaphors may be identified which do not allow for more complex interactions to be designed.

3.2 Participatory Music Interaction Design

The conceptual metaphors validated by the previous studies will be used to develop a series of rough sketches of sample software-based Music Interactions to drive the design discussions. The sketches will be kept deliberately rough and simple in concept in order to provide an impetus for discussion rather than focussing participants on improving a specific design or using a specific interaction model. As an example, a sketch for conceptual metaphors derived from the BALANCE image schema may incorporate chord objects balancing on a defined point. We anticipate the sketches will either support or contradict the validated conceptual metaphors, again providing opportunities for participants to discuss reasons for accepting or rejecting particular design suggestions.

Groups of participants will be provided with the sketches and asked to discuss and develop an interaction design for one or more musical concepts. As the purpose of the sessions will be specifically aimed at designing interactions with minimal functionality outside of the musical concepts under discussion, the participants will be chosen based on their knowledge of the musical concepts to be discussed. We anticipate the majority of participants should be experienced
musicans with limited knowledge of user interface design in order to minimise the influence of user interface design considerations external to the task.

To ensure the discussions remain focussed on designing for the specified musical concepts and in an attempt to establish the basis upon which participants made specific design decisions, we propose using the second person interview technique to question the participants throughout the sessions. The second person interview technique as detailed by Petitmengin (2006) can be used to reveal details of interviewees’ subjective experiences of a specific incident, for example thinking of an animal. Petitmengin argues the think-aloud technique, well-established within user interface evaluation circles, focuses on the participant’s judgements of the incident and their internal dialogue rather than revealing the unconscious decisions and thought processes that characterise an incident. Through the use of this technique during the sessions, we anticipate we will be able to reveal to some extent the subconscious processes involved in making design decisions thus validating the participant’s choices with the identified conceptual metaphors.

At the conclusion of the sessions we predict that the outputs will include a series of further design sketches by the participants and critiques of the sketches provided as input to the sessions. We anticipate analysis of the transcriptions of the sessions will reveal the participants’ subjective experience of discussing and making design decisions with respect to the various conceptual metaphors the sketches provided were based on.

3.3 Validating Design Decisions

In order to validate the design decisions discussed in the participatory design sessions, we propose to develop one or more prototypes based on the outputs of the sessions. A series of short informal evaluations sessions will then be carried out using the prototypes to establish whether they allow novice users to intuitively interact with the designs to manipulate musical parameters and thus whether the participatory approach to Music Interaction design based on the principles of Conceptual Metaphor Theory was successful.

4. CONCLUSION

Previous studies have shown that using conceptual metaphors as a technique for evaluating existing Music Interaction designs holds promise (Wilkie, Holland and Mulholland 2009, 2010). We anticipate that by adopting a participatory approach to designing new Music Interactions that is primarily driven by conceptual metaphors, and in collaboration with experienced musicians, we will subsequently be able to create intuitively usable interaction designs for music software principally aimed at novice users.

Implications of this work relate to the workshop themes in a variety of ways. Firstly, to the best of our knowledge, this work is the first example of using a participatory approach to interaction design driven by conceptual metaphors in any domain. Secondly, such an approach will provide the foundations for the development of methodology for a conceptual metaphor based approach to interaction design in the domain of music.

5. REFERENCES


We can work it out: A participatory approach to designing music interactions
Wilkie, Holland, Mulholland


