

What Makes an Auditory Diagram Diagrammatic?

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The study of External Representations have recently been given much attention in the shaping of modern Cognitive Science theories. This is directly resulting from a growing awareness of the integral role played by external representations in a cognitive reasoning system, significantly influencing the forms and processes involved in constructing and manipulating internal representations to determine intellectual behaviour.

Diagrammatic representations are a form of external representations that have long been the subject of interest to many broad and specialised areas of research. Within theories of visual languages, two main categories of research separately look at two different aspects of these notational artefacts; the first is concerned with the development of ideal formalisations of the semantics of diagrammatic representations, whereas the second looks at the cognitive aspects of using such artefacts when they interact with human interpretive and reasoning faculties, i.e. perceptual rather than formal semantics of external representations. It has been suggested that an encompassing theory of diagrammatic communication should account for both the pragmatic issues related to human interpretive abilities and reactions to representations as well as more specified formal semantic modelling of such interaction (cf. [Gur99]).

We are mainly interested in the impact of the perceptual semantics of representations on human cognition. However, while we consider the above concerns and theoretical advancements of major importance to the development of fuller and deeper understanding of diagrammatic representations, we see them as clearly limited to the boundaries of a singular – visual – medium of presentation. This excludes any considerations for the potential of incorporating different modalities to present and communicate parts of, or whole representations.

Looking at advances in the area of Sonification and Auditory Display, on the other hand, there is increasing evidence of the potential to use audio as means for communicating rich levels of meaning in a variety of domains. Of particular interest is research which focuses on providing alternative auditory displays for improving accessibility to otherwise visual artefacts, such as pictures, graphs, and diagrams. Many efforts into designing such artefacts tend to be inadequate even though, and perhaps because, they provide direct translations of visual external representations.

We suggest a novel theoretical approach to examine the design of audio only displays for otherwise graphical information in terms of their roles as external representations. The approach is based on the idea that cross-modal translation processes should emphasise the semantics of the represented information rather than the functional features of the medium that presents it. We exemplify this by exploring the design of a hierarchical representation to organise relational information encoded in a UML diagram. Initial experimental studies showed that increasing interaction levels with the representation to match the semantic perceptual views of the relational information positively impact performance, whereas varying presentation modes does not. Our overall findings favours the approach and testifies to the success of the hierarchical representation in supporting non-visual inspection and navigation of information encoded in relational diagrams. Characteristics of external representations were successfully implemented in the

representation and their effects on interaction observed when it was communicate through sound only. Through introducing this approach we thus propose that auditory displays, particularly those that provide access to visual external representations such as graphs and diagrams, can and should be studied under a representational taxonomy based on the properties of external representation.

Another property of External Representations that that gives them an even more important role in intellectual activities is their communicative function. Once mastered, a visual diagrammatic language can become an extremely efficient means for communication. Yet again, there is an evident lack of research on cross-modal collaboration in the fields of Auditory Display and Computer Supported Cooperative Work. Thus, to further our investigations into the nature of auditory diagrammatic representations, we intend to deploy the developed approach for designing auditory diagrams in collaborative problem-solving contexts. The fact that very little work has been directed towards cross-modal collaboration in this case forms both an advantage to the proposed research, in that it increases its originality, and a disadvantage, in that no solid empirical or experimental background exists on which to base our work.

An important step to take before arriving at deploying these artefacts in collaborative contexts is to provide appropriate levels of interaction to support idea formulation and expression through the artefact of communication. Findings from our initial investigations showed how matching interactive possibilities to the perceptual semantics of a representation improves performance. More interaction than mere inspection and exploration of the represented information is however necessary in a group activity. We thus intend to take the interaction with the implemented auditory diagrams to the next obvious level of constructing the actual representation itself.