ARE COGNITIVE STYLES AN IMPORTANT FACTOR IN THE DESIGN OF ELECTROACOUSTIC MUSIC SOFTWARE?

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ABSTRACT

This paper explores cognitive style as one of the factors that may explain tensions that can exist between individual electroacoustic composers and the software they use. The discussion centres on a survey, conducted using a web-based questionnaire, of composers' cognitive styles and approaches to composition. This survey was motivated by a previous qualitative study of composers, in which two established composers unexpectedly revealed differences that mapped remarkably well onto one of the key dimensions of cognitive style identified in the psychological and cognitive literature, namely global and analytic. The results suggest that there are characteristic cognitive style traits within the electroacoustic composer community which correlate with particular approaches to composition and also to levels of satisfaction with composition software. Thus we propose a new area of research, namely, usability studies of computer music software that is sensitive to cognitive styles.

1. INTRODUCTION

Creativity in electroacoustic music composition can be impeded by inappropriate software interfaces (e.g. [5, 13]). In this paper we explore cognitive style (CS), i.e., tendencies displayed by individuals consistently to adopt a particular type of information processing strategy, as one of the factors that may explain these impediments. To our knowledge, this aspect of computer interaction has not been previously considered in the design of composition software.

Our discussion centres on a web-based questionnaire survey of electroacoustic music composers that we conducted during January and February of 2007. The questionnaire was designed to test composers' cognitive styles and their approaches to composition, with the aim of determining if correlations between composition approaches and cognitive style can explain tensions that appear to exist between the creative activities of composers and the software they currently use. Our survey was motivated by an unexpected discovery which emerged when we re-examined data from a

qualitative study of composers [22, 23]. Specifically, two established composers unexpectedly revealed differences that mapped remarkably well onto one of the key dimensions of cognitive style identified in the psychological and cognitive literature, namely global and analytic. Through analysis of our survey data we have drawn tentative conclusions relating to dominant CS traits amongst electroacoustic composers, and their correlation with composition approaches and attitudes to software. Thus, the survey provides preliminary confirmation that CS may be an important factor when assessing the efficacy of composition software. Accordingly, a new area of research is proposed, namely, usability studies of computer music software that focus on cognitive styles and the specific tensions these create, with the aim of developing interfaces that are sensitive to, and compatible with, the different styles exhibited.

The paper is organised as follows. In the following two sections we establish the motivation and context for this study, firstly by reviewing research into electroacoustic music composition, and secondly studies of cognitive style. The paper then presents the results of our survey of CS and composers. Finally, implications with respect to computer music software design are discussed.

2. MOTIVATION AND PREVIOUS WORK

Hypothetical and theoretical models of creativity in composition (reviewed in [3]) have focused on 'traditional' Western Art Music based on the musical grammar of tonality and notated using the traditional five line stave. In contrast, electroacoustic music is based on timbral properties of sounds. Also, as Emmerson [6] observes, "working with sounds on tape (or from computer systems) one is immediately confronted with an aural result and ... a judgment to be made and a decision to be acted upon". However, though this suggests an iterative process of test, select and evaluate, Vaggione [24] also observes that complexities of electroacoustic composition mean that it cannot be reduced to an algorithm, or rigid model. Rather, it is a complex network of interactions, despite often being based on formal or structural devices (for example, tonality). In particular, the "micro-time domain" allows

composers to manipulate compositions at a lower level of abstraction, to be able to “get inside the sound”, creating a “plurality of layers of operations of diverse kinds” [24:56]. The compositional process can therefore be seen to be a highly complicated and intricate activity, which is difficult to model objectively. This partly explains current scarcity of insightful research into the phenomenon of creativity in electroacoustic music, particularly from a software perspective. One of the problems in conducting such research is the difficulty of determining cognitive processes of composers. As Laske (cited by [16:31]) observed: “the kind of musical knowledge that, if implemented, would improve computer music tools is often not public or even shared among experts, but personal, idiosyncratic knowledge...the elicitation of personal knowledge and of action knowledge still awaits a methodology...” We also note that derivation and validation of theories of the composition process require empirical studies to reveal what actually happens. However, though widely used in audio and music perception research [20], these have rarely been used to research composition. Empirical studies of conventional pitch-based music composition have used case study data [17, 3] and controlled experiment (e.g., [1, 4]), but do not address issues relating to interaction with computer systems. Also, experimental work largely failed to address complexities of professional composition, since subjects are typically students, sometimes children, and often musically untrained. Notably, there has been very little “time-based” analysis, or studies in naturalistic settings. Few experiments have gone beyond observation of trivial composition exercises using crude and simple sound sources, exceptions being studies in [17], [3] and [5].

This lack of an established research base has motivated a series of studies in which research methodology used in the social sciences has been applied. These methods have included qualitative inductive analysis of data collected through naturalistic study [11], and using survey techniques, such as interviews and questionnaires. The study presented is the most recent of these, extending past research: by Clowes [2] into composers’ software environments; by Tracy [21] into composers’ attitudes towards user interfaces; by Upton [22] into approaches to composition; and by Eaglestone et al [5] into composers’ software requirements. Thus, the work contributes to an ongoing exploration of various aspects of the compositional process and the nature of the relationship between composers and the tools that they use. A specific motivation for the study in this paper is something that unexpectedly emerged from the study by Upton [22]. Specifically, re-examination of qualitative data collected in the study determined that approaches to composition of two experienced composers [23], who were subjects in the study, appeared to characterise stereotypical cognitive

styles. Many studies in other areas, such as those reviewed below, suggest that there are intrinsic and fundamental personal traits, referred to as cognitive styles, which influence the cognitive processes of individuals when using software. Thus, a general classification based on the cognitive styles may provide a more fundamental basis from which to anticipate and thus reduce potential tensions that currently occur between composers and the software they use. However, no previous studies have analysed composition and composition software from this perspective. The above observations motivate the research in the remaining sections of this paper.

3. COGNITIVE STYLES

Cognitive styles (CSs) are tendencies displayed by individuals consistently to adopt a particular type of information processing strategy [7, 9, 10, 12, 14, 15, 18, 19, 25].

The study reported here focused on a set of four dimensions of cognitive style. These are: global/analytic, imager/verbaliser, intuitive/sensing, active/reflector. Relatively analytic individuals tend to go about tasks in a relatively linear, sequential way. They progress step-by-step in a logical fashion. They are less concerned to grasp the “big picture” early on. Conversely, relatively global individuals tend to seek and take in information in a less sequential way, often sampling widely from the information space, and being concerned to establish the “big picture” – the conceptual map showing how concepts and ideas fit together – relatively early on, before getting to grips with the procedural details. Imagers are good at working with diagrams, pictures, charts, etc., and tend to think visually, compared to verbalisers who tend to think more in words. Relatively intuitive individuals tend to be more innovative than sensing individuals, and like to explore possibilities. They excel at taking on board new concepts and abstractions. Sensing individuals prefer more factual “real world” information, and like to make use of well established methods and approaches. Active individuals tend to be quick at trying things out, as opposed to their more reflective counterparts who prefer to think things through more before acting. Reflective individuals may often prefer to work alone, whereas more active individuals often tend to like working collaboratively.

We sought to investigate whether any of the above traits may impact on ways individuals use software, and may thus partly determine the appropriateness of the software’s design. This motivates a more specific question, to what extent does CS impact on approaches adopted by composers and hence the efficacy of the software they use? Results from a previous study by Upton [22] suggested to us this may be a fruitful line of investigation. Upton examined practical aspects of the composition process to gain a better empirical understanding of composers’ approaches to

composition and working practices. Her study comprised an in-depth investigation into a small number of composers using semi-structured interviews. Of particular interest for the current study were two of the participants, both established and experienced composers, and who have been composing electroacoustic music for many years. During a secondary analysis of the data, it became striking how many of their comments and observations (presented in [23]), mapped onto the notion of the global/analytic dimensions of CS. It should be noted that the notion of CS was not part of the research agenda of Upton's study, which consequently did not contain any instrument to measure subjects CS. However, the results of this secondary analysis do beg the questions, are these similarities coincidental, or are they indicative of a more fundamental influence of CS within the electroacoustic music community?

4. THE PRESENT STUDY

The present study surveyed electroacoustic composers' CS and approaches to composition. The study was designed to address the research questions: Do composers display cognitive styles which conform to known classifications? If so, what are the implications with respect to software environments for composition? In particular, can knowledge of a composer's cognitive style be used to create software interfaces which are better suited to their cognitive processes and hence provide more fertile environments for their creativity in music?

The survey was conducted using a web-based semi-structured questionnaire. This was composed of three parts. The first comprised closed questions to elicit profiles of the composers. The second part, also of closed questions, comprised a test to determine the CS of the composers. This test was developed by Felder and Soloman, designed to measure Felder and Silverman's four-dimensional learning styles model [8]. The final semi-structured part elicits approaches and views on composition and related software.

4.1 The sample

Completed questionnaires were returned by 27 composers. This is a small sample from a small community. However, electroacoustic composers form an individualist and idiosyncratic community, characterised by creativity and originality. Therefore, in keeping with the qualitative research paradigm, our strategy was not to seeking to generalise. Instead we focused on the qualitative data relating to approaches and attitudes to composition, and the extent to which these were consistent with the profile and CS of each individual.

The respondents represent a broad slice of the international electroacoustic composer community. The two largest groups were from the UK (11) and USA (8), but there were also responses from composers who described their nationalities as; the

Basque Country, Germany, Brazil, Australia, Canada, Greece and Israel. Respondees were mainly male (21) and aged 21-30 years (11), though there were responses from all age bands, up to 71-80 years. There was a fairly even split between those who were both musically and technically qualified (6) and those without any such qualifications (5). The majority were musically qualified (10), but not technically. Only 4 respondents had technical but no music qualification. The two largest groups described themselves as amateur composers (11) and professional composers (8). Others classified themselves as either "student" (4) or "academic" (3). All professional and academic composers, and the majority of amateur composers, were qualified musically and/or technically, and only one of the professionals had only technical qualifications. Most declined to specify years of composing experience, but those who responded had composed either for 1-2 year (3), or 3-5 years (5).

4.2 Methods

The analysis proceeded in three phases. Qualitative data relating to composers' approaches to the composition process and their views on composition software were analysed in the first phase. The qualitative data was solicited by four open questions which respectively asked: how the composers classify their compositions; their five favoured composition processes; the composition approach taken for a 10 minute electroacoustic piece, either in general or in a recent significant composition; and their critique of current composition software. Our methodology was devised to avoid bias that potentially arises when interpreting data within the context of known CS scores. Accordingly, analyses were conducted independently by the authors, prior to viewing results of the CS tests. In these preliminary analyses, composition approaches were classified as (a) entailing the composer expressing explicit concern with overall structure/form, or (b) primarily a voyage of discovery (trying things out without mention of overall structure/form). In addition, composers were classified according to the issues they raised in their critiques of software. Contentious classifications were resolved through discussion. In the second phase the above analysis was compared with the results of the CS tests to establish the extent to which the cognitive and practical approaches of the composers can be explained by their CS. Finally, we analysed implications of the findings with respect to composition software requirements.

4.3 Results

Two main results emerged from the analysis, respectively concerning the link between CS and approaches to composition, and satisfaction, or lack of it, with current software.

Refinement and synthesis-based composition approaches: Two general approaches to composition emerged as dominant among the respondees, which can be characterised as *refinement* and *synthesis*. In the former, a composer establishes the structure of a composition, and then realises and refines it. In contrast, the *synthesis* approach is more a voyage of discovery, whereby the composition inductively emerged through experimentation with audio materials.

The *refinement* approach was applied with various levels of formality by a majority (13 of the 18 composers who provided sufficient qualitative data for meaningful analysis). All of these were concerned with “form” or “structure”, as is illustrated in the following quotes from the questionnaire responses, in which phrases which we feel are strongly indicative of the approach have been emboldened. (Note that here and throughout this paper we have appended each quote with a composer identification number and their dominant CS traits for reference in the subsequent discussion.). The essence of the refinement approach was encapsulated in the following quote by composer 41,

*“I would look at the brief, **map out a structure** and then compose from that as ideas developed”* [41] [Global || Imager || Active || Sensing]

Others provided elaboration, for example, concerning interplay between seeking inspiration from audio material, and the conceptualisation and elaboration of the composition as a whole. For example, the following quotes refer to collected sounds “*leading ...to new formal and sonic directions*”, the role of “*improvisation*” and discovering “*relationships between sound materials*”.

*“I would first gather sounds (either found or generated). The gathering would be shaped by some general idea I had in mind for a sound. The gathered sounds would then lead me to new formal and sonic directions. I would affect the sounds if needed or inspired to do so and continue refining the materials and general ideas. At this point I would form a more **solid conception of the piece as a whole (i.e. a formal outline)**. I would set to work putting the piece together, allowing for shifts in direction but **generally sticking to the plan**. After a draft version was completed I would assess its strengths and weaknesses and begin work on a final version, or as a worst case scenario, begin anew. This is true of any piece, not just those that are to be 10 min long. After the draft is complete (no matter its length) edits and revisions can be made to adjust the piece to suit any requirements or limitations that may pertain.”* [56] [Global || Imager || Active || Intuitive]

“I would first conceive of a structure. Then, possibly independently, I would conceive of sound-elements and visual elements. I would then work to reconcile these elements. After creating a detailed plan controlling certain elements I would allow myself complete freedom to “improvise” the remaining elements.” [64] [Global || Imager || Reflective || Sensing]

*“Choose sound materials; develop materials (processes above) to create a large palette of sounds; start to discover & develop relationships between sound materials to **develop structural components; large scale structuring** (other sounds may be sourced along the way as deemed necessary)”* [47] [Global || Imager || Active || Sensing]

The above examples also illustrate the difficulty in classifying composition approaches, since, though all are anchored in a “*structure*” or “*formal outline*”, there are also inductive episodes in which the composer seeks inspiration from the audio material. This may be significant particularly for composers with musical qualifications, since methods may be partly determined by training and education, whereas, CS should be a factor in their application.

The above blurring of classification is also apparent for those composers whom we classified as applying a *synthesis* approach, i.e. those concerned with “trying things” out rather than having preoccupation with an overall planned structure. This approach was described by a minority (5 of the 18 composers). The essence of this approach is captured in the following quotes.

*“... **Listen for a sound that inspires me; experiment with mathematical processes. Work over a long time, listening repeatedly**”* [46] [Analytic || Verbaliser || Reflective || Intuitive]

*“Would get some of the software tools I have been developing lately and find some sound materials (no natural, always sampled) that work fine with the processes of the tools. **Test different combinations** until once I **find something interesting** then I improvise a few sets. I choose and edit/master the chosen session”* [43] [Analytic || Verbaliser || Active || Sensing]

*“I would spend a significant length of time thinking about the approach I was going to take, then would record several hours of **improvisation before selecting the ten minutes of audio** (either a single extract, several extracts montaged, or several extracts”* [50] [Analytic || Verbaliser || Reflective || Intuitive]

“explore a range of found sounds, personally sampled or collected from existing archives; cut, arrange, merge and mutilate; overlay with electronic sounds; mutate and develop” [63] [Analytic || Verbaliser || Reflective || Intuitive]

The above approaches differ in the ways the sounds are generated, experimented with, and combined to form the composition, but all essentially allow the composition as a whole to emerge through experimentation with its ingredients. However, again, there is some blurring between the approaches. For example, the following quote refers to creating a “landscape” which could be interpreted as the global structure or framework for the composition. Thus, our classifications are indicative of a main emphasis of the compositional approaches.

“Collect together some interesting samples and create a landscape from them using lots of plug in automation and resampling of sections” [49] [Global || Imager || Active || Intuitive]

Satisfaction and dissatisfaction with composition software: The second finding concerned satisfaction with current software. Again, we can make a clear binary categorisation, i.e., *satisfied* and *dissatisfied*, on the basis of the open question which solicited views on enabling and inhibiting features of current software. Of the 18 who provided substantive critiques on software, a majority (13) expressed dissatisfaction with some aspect of the software. Dissatisfaction is mainly on the grounds of lack of integration or compatibility between tools, as expressed in the following quotes.

“That they are limited to specific platforms. AudioSculpt - Mac, Nuendo, CDP, Audition, GRM, Native Inst - PC. If CDP were to have a VST front end, that would be extremely helpful.” [41] [Global || Imager || Active || Sensing]

“Inhibiting: Steep learning curve and compatibility issues between different applications and platforms. Also many pieces of software tempt the user to make loop based music” [49] [Analytic || Imager || Reflective || Intuitive]

“Enabling: customisation, flexibility, complexity. Disabling: still not enough of the above; not enough unity between different pieces of software” [60] [Global || Imager || Reflective || Intuitive]

Other related issue raised were how poor performance of the software impedes working with multiple tools or techniques, in particular on large scale compositions. Also respondees expressed a desire to have control over the processes, in

preference to automatic processes, but some composers were impeded in achieving this by technical complexities and poor interfaces. One of the explanations for the latter was the continuing influence of legacy systems and standards,

“Inhibiting: adherence to old standards or reverse compatibility regardless of objective ease of use or usefulness in general. If a thing will work better another way, it is ok to implement that other way....” [56] [Global || Imager || Active || Intuitive]

Thus, the main dissatisfaction with current software concerned lack of tools integration and interoperability, poor performance, too much automatic processing and over complex interfaces.

There was also a significant group (5) who were mainly satisfied with current software, as illustrated in the following quotes:

“I like SoundHack for its practical approach and csound for its universal applicability to a range of compositional approaches.” [52] [Global || Verbaliser || Reflective || Intuitive]

“The transfer of large recorded tracks and the navigation through them has become far quicker in just the few years I have been composing in this manner. As I do not use complex processes, there are no obvious inhibiting features.” [50] [Analytic || Verbaliser || Reflective || Intuitive]

“I can create algorithms that allow repetition and refinement. [I] miss provenance information but am working on it” [46] [Analytic || Verbaliser || Reflective || Intuitive]

“Enabling: range of possibilities, including ability to build your own tools. That opens a huge space to explore. Inhibiting: I also love to compose with an electric guitar. It is another story than using software. Less rational, I guess because of history and assumptions in the instrument give a direction to composition. Same could be said about software but the physical element gives the process a different nature.” [43] [Analytic || Verbaliser || Active || Sensing]

“I have a wonderful interface to behave quite visually with, as well as the potential for electronic metamorphosis provided. Inhibiting features? I think that depends on my own approach to the materials at hand.” [59] [Global || Imager || Reflective || Intuitive]

This group is not entirely uncritical, for example, composer 43 comments on the lack of a specific type of physical/tactile interfaces, but they are largely satisfied with the expressiveness and manipulative

power of current software. However, inspection of the musical styles and tools they use suggests the composers in this group represent a fairly narrow thread of electroacoustic composition, mainly involving programming, for example, in algorithmic composition, rather than use of functional composition tools. Also, the final quote, by composer 59, is an endorsement of the software they use, but since this is “home made” software, there is also an implicit criticism that existing software interfaces were not sufficient for their particular composition approach.

Discussion of Cognitive Style: Subsequent to the above preliminary analysis of the qualitative data, we sought correlations between our classification and the CS traits of the composers. CSs were determined using the tests of Felder and Soloman, which quantifies four aspects of CS on a scale of [-7,+7], thus positioning each respondent within a four-dimensional CS space. As described in section 3, these dimensions are: global/analytic, imager/verbaliser, intuitive/sensing, active/reflector.

Some trends are apparent in this sample. There is a small skew towards imagers (as opposed to verbalisers), and reflectors (as opposed to activists). However, there is a very pronounced skew towards global individuals (73%) (as opposed to analytics) and intuitive (77%) (as opposed to sensing). A large majority of professional and academic composers have, to some extent, possessed both global and intuitive CS traits. Thus, the “typical” electroacoustic composer within our small sample is global/intuitive.

Referring back to our analysis of the qualitative data, there is an obvious interpretation in terms of CS traits, of the binary divide between those composers who take *refinement* and *synthesis* approaches. By initially defining a structure for the composition, it can be argued that a holistic or global approach is being taken by the former, whereas, the inductive nature of the synthesis approach is more characteristic of the analytic or serialist. Thus, one would expect composers in the two groups, respectively, to have positive and negative scores relating to the analytic/global trait. Interestingly, this proved to be true for 89% of the cases. 12 of the 13 composers who adopt the refinement approach had global traits, whereas all but one of those who described a synthesis approach had analytic traits. In addition, and more surprisingly, the refiners and synthesisers respectively mainly had imager and verbaliser traits (10 of the 13 refiners were global/imager, whereas 4 of the 5 synthesisers were analytic/verbalisers).

Our second classification in the preliminary qualitative analysis was of the composers who were respectively discontent and content with the composition software they used. We were therefore interested to see if there was any CS trait which appeared to distinguish the malcontents from the

contents. The characterising trait proved to be the imager/verbaliser dimension. 11 of the 13 discontents were imagers whereas 4 of the 5 contents were verbalisers. This raises the intriguing question, why are verbalisers less critical than imagers? Closer inspection of the data provides a tentative answer to this, in that all of the discontented verbalisers used programming languages as their main composition tool, e.g., for algorithmic composition, whereas the criticisms of the imagers concerned mainly the interfaces of existing tools. Also, the one imager within the contented group (composer 59) could possibly also have been classified as a malcontent, since, rather than endorsing the quality of current software, they have created their own software interfaces, presumably to better support their particular approach to composition.

5. IMPLICATIONS FOR COMPOSITION SOFTWARE DEVELOPERS

The study presented here was designed to seek evidence regarding the impact of CS as a significant factor when designing composition software. Though based on a small-scale survey, we believe the correlations between composition approaches and attitudes and CS are too strong to be dismissed as arbitrary phenomena.

We draw a number of tentative conclusions from this small survey which suggest further research may be fruitful.

- Firstly, there are dominant CS traits apparent in our sample of electroacoustic composers. Specifically, these are mainly global (rather than analytic) and intuitive (rather than sensing).
- This in turn explains the dominance of composition approaches based on defining and then realising a global structure, since the composers who adopted this approach are predominantly global, whereas those who adopt a more inductive approach in which the composition emerges through experimentation are mainly analytical.
- Further, satisfaction or dissatisfaction of composition software appears to be determined by the imager/verbaliser CS trait, the verbalisers being largely content and the imagers being largely discontent.

A tentative conclusion could be that software is well design for verbalisers, since these were mainly satisfied, whereas imagers are currently poorly served by composition software. Further, since the majority of the complaining imagers are also global, it is mainly the composition *refinement* approach that is currently ill-supported by software. However, this is clearly too simplistic since the small number of contented verbalisers in the sample are predominantly programmers, for example, for algorithmic

composition, who by nature create their own functionality and are more tolerant of textual interfaces. Also, though imagers' discontents focus on the software interfaces, they identify a diversity of issues, ranging from complexity of technical interfaces through to the need for abstract notation/scoring systems and greater integration and interoperability between tools. Collectively, these are issues which are particularly important for supporting a holistic approach to composition, but it can also be argued that "voyage of discovery" composition also requires integrated use of multiple tools with "clean" interfaces.

Thus, the conclusion of this small-scale study is to add evidence that supports the hypothesis that CS is an important factor when evaluating the efficacy of composition software. Therefore, we believe a more extensive survey of CS and composition is required, together with usability studies to determine the efficacy of composition interfaces for specific CS traits. A long term aim should then be to develop interfaces that are sensitive to, and compatible with, the different CS styles exhibited.

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