Sense of Authorship and Agency in Computational Creativity Support

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Abstract

The co-creation of human and artificial intelligence in creative environments raises novel questions regarding the authorship of the crafted results. The traditional notion of attributing authorship to humans by default becomes increasingly challenged. In particular the factual contribution to authorship and the *experience* of authorship can become more divergent. Thus the perception for alternative designs can be different, although those require a similar amount of contribution. Especially in the creative domain, users favor personal expression and thus naturally want to feel as the authors of a created result. If a system cannot provide this sufficiently, the overall experience is negatively affected. However, usually systems are not evaluated deeply in this regard. To better guide design decisions that result in satisfying experiences, this aspect needs to be integrated in its evaluation. We suggest to further explore a technique that emerged from neuro-science; for this, we provide examples of application, discuss limitations and future work.

Author Keywords

User interface; sense of agency; sense of control; sense of authorship: implicit measures; intentional binding.

ACM Classification Keywords

H.5.2 [User Interfaces]: User-centered design, Evaluation/methodology, Theory and methods.

Sense of Authorship and Self-Agency

We gladly delegate daily chores and other unwanted tasks to an automated or (semi-)intelligent supportive system. In contrast, in a creative process, we want to actively express a personal take on a chosen subject matter [11]. With the introduction of creativity tools that are supported by computers and artificial intelligence (AI), both agents involved – user and system – contribute to the created content. With the capabilities of nowadays AI, the contribution of systems became extended even to higher level decision taking; a domain that originally was exclusive to human contributors. Authorship therefore can no longer only be attributed to humans simply by default. In consequence, questions on our changing relationship towards authorship arise.

A first obvious category of such questions might ask who is now the author and to what degree. Similar discussions started with the upcoming of photography as an arts discipline [3]. At the time, it was being questioned as a legitimate discipline of artistic expression by some traditional painters. They argued that the artist was no longer the solemn creator of a resulting image and became merely a button presser. As these questions are rather philosophical in their nature, they do not necessarily contribute much to the realization and evaluation of such systems in a practice. However, there is also a more practically relevant angle to these questions focusing on the degree of *experienced* authorship of a creative while working with such co-creative tools.

The experience of authorship is based on the perception of control and self-agency [13]. Concerned with control, a large body of work has been previously conducted [18]. If a design lacks to provide it, performance and user experience are negatively affected. In order to shape a positive experience, several design solutions for graphical user interfaces were proposed and applied. This led even to incorporating deceptive strategies such as faked responsiveness, faked progress indicators or placebo buttons [2, 16]. Control and authorship are related, yet different. For control, concrete designs were already proposed and similarly they are necessary for promoting sense of authorship or else negative effects on user experience can be expected. The exploration and evaluation of such designs for a human-AI co-creative environment however still is part of future research.

In the evaluation process, usually some form of data is collected, analyzed and interpreted. This data is often collected either *explicitly*, e.g. via questionnaires, or *implicitly* by collecting data related to the human system. In neuroscientific research, new forms of measurements on an implicit level on authorship and self-agency were examined in recent years [4, 13]. In this field, the phenomenon is referred to by multiple terms, with *sense of agency* being prominently used at the moment. Based on presented fundamental research, an evaluation tool for measuring implicit data has been proposed. It was already applied within the field of human-computer interaction (HCI) [7, 13, 14], but so far mainly in contexts limited to discrete control operations with studies conducted under laboratory conditions. To turn it into a viable tool for researchers and practitioners, we believe further exploration, understanding and validation in the field of human-computer interaction is still necessary.

How to Implicitly Measure Sense of Authorship

Given the limited space of this paper, we will only outline a short overview of the preceding work in regards to implicit data collection on sense of authorship and agency. For a detailed introduction to the topic we recommend the surveys provided by Berberian et al. [4] and Limerick et al. [13]. Briefly summarized, the methodology emerged from fundamental research in neuro-science concerned with schi-

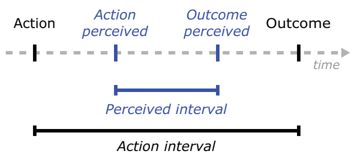

Figure 1: Time warping effect in experiencing sense of agency [13]

zophrenia. Researchers investigated how someone with this condition experiences or respectively lacks the experience of self-agency during their actions. To measure the degree of experienced self-agency, they built an evaluation tool. This tool exploits a time-warping effect in the temporal binding processes of the neuronal system (Figure 1). Simplified, one could say that humans experience the passing of time faster when they experience self-agency. This was found to be measurable on time-scales that range from ~150ms to ~1500ms. For this method to be applicable, the action needs to be carried out *intentionally*. As presented in the literature, there exist two main approaches for these types of measurements. The first uses the Libet clock[1] and requires more cognitive resources from users. The second is the so called *interval estimation* and requires less cognitive resources. In HCI, both measuring approaches have already been applied [7, 14]. As interval estimation requires less resources from users, it can be integrated more easily into continuous interaction processes. It is, in our opinion, therefore better suited for a broader application in the field of HCI. How it works is explained in the following.

At first the participants are given a custom study task. Once they carry it out, a certain fixed time interval is given where they only work on this task. During this time, two further time intervals are randomly chosen from a range between 150ms to 1500ms. The first random interval is added to the fixed interval. Once this time period (fixed plus additional) has passed, a first stimulus is presented. The stimulus can be as simple as an audio cue, e.g. a "beep". After the first stimulus and an additional time of the length of the second interval, a second cue, e.g. another "beep", is presented. Then the participants are asked to guess the timespan between the two stimuli. The actual durations and the interval estimations of the participants are recorded. Based on the analysis of the recorded data, insights on the presented interface or system conditions can be derived. Here, shorter estimates are associated with increased self-agency.

This approach was for example used by Coyle et al. [7] who compared a skin input user interface to traditional keyboard input. Here, implicit measurements were used to conclude that the skin input device leads to an increased sense of agency. In a similar experiment speech recognition was compared to keyboard input [14]. Based on their experiment and the implicitly collected data, the authors concluded that speech recognition leads to a decreased sense of agency. Prior fundamental research states that bodily or physical involvement is important for the emergence of sense of agency and with increased physical involvement also a increased sense of agency should follow. This was also observed in these experiments as the conditions with more physical input led to an increased sense of agency (skin input in [7] and keyboard in [14]). Beyond different input modalities, also varying degrees of automation were studied, e.g. on the example of an auto-pilot system for airplanes [4]. Here, the authors concluded that, counter-intuitively, more automation can lead to an increased sense of agency. Yet only for as long the results the auto-pilot produced were predictable and of high quality. However, if the quality of control decreased, the sense of agency also decreased and was even lower than in the manually controlled condition. Taking these findings into account, an experiment was conducted examining which factor is more dominant [19]: physical involvement or quality of results. The experimenters created therefore situations where both aspects were incorporated in a study task. They varied the conditions such that each aspect would at times be more relevant to the outcome. The authors found that performance was more dominant than physical activity.

[1] The approach was originally used in Libets famous experiment [12] examining the question on whether humans are determined or not.

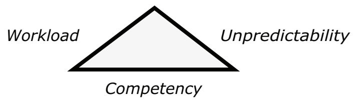

Figure 2: The trade-off between workload and unpredictability in automation from Miller et al. [15]

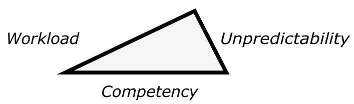

Figure 3: System design with increased human management

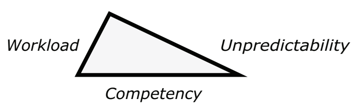

Figure 4: System design with increased system management

Why Measure Sense of Authorship Implicitly

Regarding measurements on an explicit level, there exists a broad range of well established questionnaires. They focus on different aspects such as the *locus of control* [20], the *sense of control* [9, 10], the *sense of agency* [19], the *sense of authorship* [1] etc. Despite their different orientation towards authorship and/or self-agency, they have common disadvantages. Those are mainly due to the nature of their design and summarized in the following. In asking directly on certain items, researchers reveal their interest to the study participants. This can lead to interferences by reporting bias or social desirability bias. When measurements are meant to be taken continuously in a study, the carried out task needs to be interrupted. This also leads to biased data [8]. However, when the data is collected at the end of a task, the data can be biased in a way that it represents rather an "averaged" experience of the whole task. Then, a further differentiation is not possible and occurring concentrations to peaks or lows cannot be identified. For explicit data collection, often rating-scales are used as the reporting format. These rating-scales, can at times be too coarse to identify a present main effect in the statistical analysis. This can lead to a false-negative (or Type 2 error). Consequently, if one wants to make sure that there is no difference between the studied designs, as in equivalence testing, this too coarse data might indeed indicate there is no difference. However, in reality there is a difference that could not be detected as the tool was not sensitive enough.

These issues can be made up for when using implicit measures additionally. Contrasting both types helps to counteract the weaknesses of using either approach in isolation. Thus, one should aim for collecting data implicitly as well as explicitly to come to a more convincing conclusion. Concerned with evaluating creativity support tools, using multiple techniques in a cascade was also recommended in [17].

Fundamentals of an Evaluation Framework

In regards to automation, consequences on the relationship between humans and automated systems were already observed by Miller et al. [15]. They found that, depending on the degree of automation, reducing workload led unavoidably to an increase of the unpredictability of the results (Figure 2). This implies that when intelligent systems take initiative in a creative process, it necessarily affects the predictability of the results. This further can affect the sense of agency as suggested by [19].

We suggest to take this observed workload-unpredictability trade-off as a basis for an evaluation framework. This means to develop a framework that determines workload and sense of agency. On an explicit level, both measurements can already be taken with questionnaires as mentioned earlier. On an implicit level, workload can be estimated via the heart-rate or the pupil diameter, but also other tools exist. One way is the use of a detection-response tasks (DRT) [6]. In a DRT, a stimulus is presented to a participant at multiple randomly assigned occasions besides a main study task. As stimulus, usually a LED is lit up at the assigned times. The participant is instructed to react as soon as the stimulus is recognized. To indicate its recognition, often a dedicated button needs to be pressed. The reaction times are recorded and used as an indicator for the occurring workload of the main task. From an increase in the reaction times also an increase in workload can be derived.

For the presentation of the stimuli and the recording of the reaction times, a certain apparatus is obviously necessary. The collection of data on sense of agency using the interval estimation technique also requires the presentation of simple stimuli and the recording of estimation times. We believe that the apparatus necessary for a DRT can easily be extended in a way that it additionally allows to collect data on sense of agency implicitly. All together, workload and sense of agency could be determined with the same apparatus, simultaneously and at multiple times while users conduct a given study task. After each task, of course measurements can be taken explicitly to supplement the results. As HCI covers interaction in physical and virtual environments, feasible evaluation solutions that work across environments and input modalities are preferable. The principle of estimating the workload-unpredictability trade-off via an extended DRT, is not restricted to use in physical environments. The audio-visual cues that are necessary can be transferred to the virtual realm. The first step towards a virtual implementation is the presentation on a mobile device. Here, presenting a visual stimulus that simulates a flashing LED or presenting an audio cue seems feasible. The second step further into virtuality is the implementation in virtual reality (VR). DRTs have been used in VR before, so also an extension as proposed seems manageable.

Application and Future Work

In contrast to chores, creative actions are a mainly voluntary form of actions. As this evaluation approach assumes voluntarism, creative tasks therefore are well suited as study context. In addition, the lessons learned on the effects of automation are interesting and non-trivial. They indicate that sense of authorship and agency are not simply decreasing linearly with increased automation. Based on this, it is reasonable to assume that further advancement of intelligent "automation" – as with AI – does not enter a degenerating line of research in regards to self-agency. Further, as they integrate *both* mentioned aspects, mixed-initiative interfaces for co-creation lend themselves to the examination of personal experiences of authorship in this novel and high-level dialogue between humans and AI. However, these preliminary findings have not yet been confirmed outside laboratory environments and also have not been tested in combination with systems incorporating artificial intelligence. Also, it became apparent that self-agency is connected to certain constraints. Yet, these constraints are not clear and need further investigation in order to guide design decisions. To come to a better understanding of the experience of authorship in a high level dialogue between humans and machines, an elaborate evaluation framework is missing. For its development, the presented methodology can provide necessary bits and pieces. For researchers its application can help to extend the understanding of the phenomenon. For practitioners it increases the ability to take better decisions in designing a system. Of course, further metrics are highly relevant for the evaluation of tools for creativity support. Data on multiple domain specific dimensions such as expressiveness, enjoyment or collaboration, can be collected with the Creativity Support Index [5] questionnaire on an explicit level. As mentioned earlier we suggest to incorporate our framework into an overall evaluation cascade as recommended in [17].

Conclusion

With the use of artificial intelligence in creative tools new questions on authorship in general and the perceived authorship of users in particular emerge. For the second aspect a novel evaluation methodology was developed in fundamental neuro-scientific research. It was already applied in an HCI context, but its integration into an elaborate evaluation framework is still missing. In addition, there are no prior reports on its use with AI. Based on the work conducted so far, it seems that the human sense of authorship is not simply restrained by the introduction of automation or AI. Yet at the same time, it is also bound by certain constraints. To gain insights necessary for guiding design decisions, we therefore believe, an evaluation framework integrating this aspect is relevant to the field and needs further development and validation.

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Locus of Control questionnaire in Appendix D.