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Variants of Semantic Instability (*SeIns*) in the arts.

A classification study based on experiential reports

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This paper is „in press“ (Psychology of Aesthetics, Creativity, and the Arts)

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Abstract

Many artworks challenge our perceptual habits and predictions and offer a plurality of potential meanings. However, a conceptualization of such Semantic Instability (*SeIns*; X & Z, 2016) and its specifics is vague, yet. We recently presented an extended and systematized view on the concept integrating psychological and art theoretical accounts. In order to structure the perceptual and cognitive phenomena associated with *SeIns* in art, we now conducted an initial classification study and collected reports of experiences regarding a range of 17 artworks from the 20th and 21st centuries reflecting a variety of *SeIns* concepts. We revealed four clusters of *SeIns* via a *k*-means analysis: 1) integrative blend, 2) multistability, 3) indeterminacy, and 4) contrast to perceptual habits. This seminal classification aims at providing the basis for a new and more systematic view on *SeIns* in art.

Keywords: Ambiguity, Indeterminacy, Semantic Instability (SeIns), Art perception, Predictive Coding

1. Introduction

Russian formalist Shklovsky (1917) claimed that the technique of art is

to make objects 'unfamiliar', to make forms difficult, to increase the difficulty and length of perception because the process of perception is an aesthetic end in itself and must be prolonged. [...] Art removes objects from the automatism of perception in several ways (p. 280; referring to artistic language).

We are interested in these “several ways” to challenge the recipients’ perceptual habits that modern and contemporary artists employ. Tony Cragg’s sculptures (see Figure 1C), for instance, offer a plurality of (potential) depictions and meanings and defy any single determinate identification, while Meret Oppenheim’s “Frühstück in Pelz” from the year 1936 (a tea cup on a plate with a spoon all wrapped in fur, see Table 4) contradicts common perceptual habits. In both cases, the recipient will experience a perceptual challenge due to *Semantic Instability* (*SeIns* [sams], X & Z, 2016); the question is, however, whether there is a difference between such experiences induced by different works of art as they employ different variants of *SeIns*.

SeIns is not restricted to the domain of art perception—as we describe below, it might actually account for perceptual processes in general—but it has a special status as a (sometimes intended) characteristic of many artworks. While the programmatic character of *SeIns* has been applicable to art since the epoch of modernity (associated with the 19th and 20th centuries), with regard to symbolistic and surrealist art (Krieger, 2010), for instance, the first deliberate usage of ambiguous manipulations of picture elements is thought to have already occurred much earlier. It is even very possible that human interest in the invention of plural levels of meaning is more or less cross-cultural and cross-epochal; e.g., think of intentional ambiguity in poems and lyrics as well as in pretend play, ambiguous characters in epics, films, and myths, for instance Shiva who, as one of the three major deities of

Hinduism, is neither found born nor found dead and who shows many benevolent and simultaneously fearsome forms. After all, each representation as such embodies the “dichotomy” between the depicting material and the depicted scene with it (a term recently brought up by Pepperell, 2015). So while we assume that every perceptual process holds the potential for the experience of *SeIns* (like we can repeat a word again and again until it sounds unfamiliar), artists deliberately played with such *SeIns* in certain periods and ways. An according important marker in the history of art is for instance the 16th century when (at least Western) art left the sphere of the religious context which had forced it to generate determinate interpretations of symbols (Krieger, 2010). At this time, we find many multistable depictions, i.e. figures that we can perceive in more than one way, in the arts. For instance, images which allow for dual interpretations of landscapes vs. faces, or compositions of fruits and vegetables versus human heads (Gamboni, 2002). Later artistic practices furthermore engaged in an investigation of representation itself (starting about the mid-1880s, see Gamboni, 2002). One aspect which might have played an important role in this shift in painting might have been the invention of photography and other methods of reproduction (Gombrich, 1950/2002; Meinhardt, 1997). These techniques opened up new possibilities that challenged the unquestioned functional role of painted images (note though, that the aim of many paintings before that time was not a veridical representation of a real scene; think of depictions of biblical or mystical content involving supernatural elements or the common practice of painting from other paintings). Hence, this era is marked by an increasing reflection on the characteristics of images as such and by experimentation with, and the challenge of, representation in art involving different degrees of abstraction (Meinhardt, 1997). Some of these new modern artistic approaches violated perceptual expectancies and

habits, which might explain to some extent why art from the end of the 19th century and beyond is often strongly linked with perceptual and cognitive challenge.

Although the basic idea that modern art especially (but *not exclusively*) challenges perception because it includes ambiguity and indeterminacy is widespread in art theory (Fiedler, 1971; Gamboni, 2002; Krieger, 2010; Meinhardt, 1997; Pepperell, 2011; Shklovsky, 1917) as well as in perception science (Jakesch and Leder, 2009; Mamassian, 2008; X, Y, & Z, 2015; Van de Cruys and Wagemans, 2011; Zeki, 2004), empirical work on how art induces *SeIns* in perceivers and how *SeIns* impacts aesthetic evaluation is sparse. The present article contributes to this field of research by conducting a classification study based on subjective reports of the experience of artworks. It hereby draws on an entirely theoretical framework of *SeIns* previously provided by X & Y (2016) that we will introduce in the next chapter.

1.1 Variants of SeIns

In the strictest sense, the psychological definition of ambiguity refers to the presence of multiple possible interpretations offered by the same object; or as Zeki (2004) put it: ambiguity “is not uncertainty, but certainty—the certainty of many, equally plausible interpretations” (p. 175). The corresponding perceptual effect can be demonstrated with the help of bistable pictures such as the Rubin vase that may be interpreted as a vase *or* as two faces (see Figure 1A; note that we could include the random pattern as a third layer of interpretation and thus we might, and should, speak of multistability rather than of bistability). Zeki applies this definition not only to more or less simple, ambiguous figures and optical illusions, but also to works of art. According to his view, the facial expression of the girl depicted in Vermeer’s “The Pearl Earring”, for instance, offers different, equally

plausible interpretations (“at once inviting, yet distant, erotically charged but chaste, resentful and yet pleased”, p. 189)—albeit on a higher, narrative level. Alternatively, we could state that while the girl’s expression does not fit into any specific mimic category alone, it transcends all well-known categories to create a new one. In this sense, the image is *not* reducible to switching between some established determinate interpretations. As the alternative analysis of Vermeer’s painting demonstrates, one important capability of art is to let something novel emerge by bringing together inconsistencies within one and the same object. Such an emergence of novelty is not only inherent to artworks like “The Pearl Earring”; it can also be observed in artworks offering unusual combinations of objects, object components or materials such as Meret Oppenheim’s “Frühstück in Pelz” from the year 1936.

[please insert Figure 1A-D about here]

In order to capture various characteristics of objects that defy a determinate interpretation beyond bistability and multistability, we recently resumed four phenomena under the term *Semantic Instability* in a conceptual approach (*SeIns*, X & Z, 2016): multistability, dichotomy, visual indeterminacy, and experience of hidden images. This theoretical review of these variants of *SeIns* was grounded on predictive coding—a theory from cognitive science rooted in von Helmholtz’s (1866) account of perception as knowledge-driven inference. Here, cognitive systems are described as “pro-active” (Clark, 2015); not passively receiving input, but predicting it. A constant comparison between sensations and predictions formed on the basis of prior experiences generates so-called prediction errors in cases of a mismatch; the system only deals with those errors and ignores the matches (Clark, 2013). From this perspective, perception can be understood as a process that aims at increasing semantic stability by reducing prediction errors and thereby decreasing

the chance of being surprised (Friston, 2005). Note, however, that although the drive to reduce prediction errors might be reflected in preferences for stable states, we also have to exploit resources, learn and explore and hence, to keep viable we constantly put ourselves into semantic (and bodily) instability.

Predictions themselves are based on mental models formed and adapted throughout ontogenesis so as to provide most specific predictions about the world, which enables the execution of adequate actions to keep the system viable. Concretely, the prediction of how much power you have to invest to lift a box is a consequence of such models. In Clark's conception, perception and action are closely linked like this within the framework of predictive coding and we can therefore imagine cognitive systems to be constantly engaged in predicting upcoming states and acting in order to instantiate some of these states in a flow of perception-action loops: "We predict the sensory consequences of our own action and this brings the actions about" (Clark, 2015, p. 7) and at the same time "descending signals are already (just as in the perceptual case) in the business of predicting sensory (both proprioceptive and exteroceptive) consequences" (Clark, 2015, p. 9). From this perspective semantic stability neither applies to the "outside"-world nor to the perceiver's perceptual and cognitive structure alone, but rather emerges from the dynamics of the delta between stimulation and prediction embedded in physical interactions. Such deviations from predictions are not rare but rather part of the typical perceptual process (btw, each change can be understood as a prediction error) and we should consider instability as a transition between more or less stable states. Semantic stability might therefore not exist "out there" but results out of and changes with our active "sense making". For enactive approaches this is the defining property of cognition as to preserve and enable the continuous existence of a system,

it must regulate its interactions with the world and meaning is a consequence of this specific relationship: "For the enactivist, sense is not an invariant present in the environment that must be retrieved by direct (or indirect) means. Invariants are instead the outcome of the dialog between the active principle of organisms in action and the dynamics of the environment" (Di Paolo, et al., 2010, p. 39). We cannot fully bridge accounts of embodiment and enactivism with those of predictive coding on a theoretical basis at this point (but see Clark, 2015). Nevertheless, it seems clear that semantic stability is rather a consequence of active perception than a precondition and prediction error minimization might be a dynamic and incomplete process which is determined by the system forming the predictions by interaction (which is itself again formed by previous interactions). Some artworks point us to these processes of active perception by complicating prediction error minimization. By *SeIns* we refer exactly to these *experiences* of semantic instability—consequently this means that we have to focus on processes of experiencing that are marked by the challenge of matching sensations to hypotheses about the world (see also Gregory's idea of *perceptions as hypotheses*, 1980). In other words: In the light of predictive coding, *SeIns* is the experience of a continuously repeating formation of prediction errors and prediction matches—be they switching between faces and vase when looking at Figure 1A or struggling with a determinate interpretation of the facial expression in Vermeer's artwork. Van de Cruys and Wagemans (2011) claim that artists make use of prediction errors by producing slight deviations from perceptual habits and that a predictive progress during further engagement induces positive affect in perceivers. We are interested in the differences between such artistic approaches and identified four variants of *SeIns* they induce for perceivers in a previous conceptual attempt (X & Z, 2016): In the case of *multistability*, several mutual exclusive matches can be established based on one object (Kubovy, 1994; Zeki, 2004). This 'principle of exclusivity'

(Leopold & Logothetis, 1999) can be described from the view of predictive coding as well, namely as being based on a kind of meta-prediction or “hyperprior” (Hohwy et al., 2008, p. 691): experience teaches us that sensation has one cause only at a single place and time.

When we look at paintings, there is another variant of *SeIns* at play that transcends the mere content-internal dynamics of matches and mismatches to predictions and complicates the principle of exclusivity: *dichotomy* (Pepperell, 2015) signals that incongruent semantic stabilities coexist between material (canvas and pigments), composition (arrangement of color), and content (depicted scene). This way we are, for instance, able to describe the particular way in which a painter was able to represent a scene as we combine the focus on color, composition and surface quality of the material with a focus on the represented content. Figure 1B reveals how material (in this case paper) and content (in this case a man’s back) can even interact to produce an illusion; namely the illusion that the content can influence the material—the depicted man seems to be able to tear apart the paper that represents him in the first place. A third variant of *SeIns*, *visual indeterminacy* (Pepperell, 2011) or *semantic potentiality* (Gamboni, 2002) describes cases in which objects are evocative of an identifiable pattern but do not provide determinate identification. This is, for instance, the case in Cubist artworks which defy a determinate interpretation of Gestalt while still giving cues on concealed objects (Gombrich, 1960/2002), like parts of a violin’s body or strings. This variant of *SeIns* can also be found in sculptures made by Tony Cragg that allow for concurring directions of interpretation. The sculpture shown in Figure 1C, for example, might remind you of a squeezed can or of part of a machine. In contrast to multistable objects, works that are marked by visual indeterminacy never allow for a full or certain match with any single interpretation or prediction. A fourth variant of *SeIns*, *experience of hidden images*, is marked by concealed identifiable patterns as well; but whereas these are difficult

to find, they can actually be identified clearly after a while (Gamboni, 2002). A prominent example from the field of vision science is Dallenbach's (1951) picture shown in Figure 1D, which challenges identification but finally allows you to perceive the head of a cow.

These four reviewed variants of *SeIns*—multistability, dichotomy, visual indeterminacy/semantic potentiality and experience of hidden images—might not comprise every aspect, but probably some important variants of *SeIns*. They are clearly linked to each other and so are not disjunctive. Nevertheless, they can be differentiated along three major dimensions (see X & Z, 2016): A) exclusivity of interpretations, B) flexibility of semantic stabilities (matches to predictions) and C) number of levels of involved meanings. While interpretations in multistability and hidden images are exclusive to each other (e.g., we can neither perceive vase and faces at once nor cow and random dots), the case is less clear for dichotomy and visual indeterminacy/semantic potentiality and is a matter of strong debate in art theory (e.g., Gombrich, 1960/2002; Wollheim, 1982). The flexibility of semantic stabilities is moderate in the case of multistability and dichotomy, while visual indeterminacy/semantic potentiality might be understood either as an infinite semantic flexibility or no flexibility at all because no determinate interpretation is formed in the first place. In the case of hidden images, we are mostly unable to switch back to the basic indeterminate state once we have arrived at a clear identification and so flexibility is very low after identification. While dichotomy involves several levels of predictions (e.g., material quality and depicted content), multistability is mostly associated with one level of predictions, namely regarding the identification of an image's content. Visual indeterminacy/semantic potentiality and the experience of hidden images (if we know about them being hidden images) are both strongly influenced by yet another level of prediction: We form predictions in the sense of “expectations” about recognizable content and match

them to current sensations. As long as this expectation is unfulfilled, we perceive a prediction error on this level of perception. Although this is a constant state in the case of visual indeterminacy/semantic potentiality, the prediction error is resolved during the experiences of hidden images as soon as we gain insight into the concealed Gestalt.

1.2 Research questions and hypotheses

The present study is grounded on the described *theoretical* framework of *SeIns* (X & Z, 2016) but attempts to provide an initial *empirical* approach to the variants. We hypothesized that people's experience of artworks from the 20th and 21st centuries includes characteristics of the four previously suggested variants of *SeIns*. Whereas these variants might be generalizable to all instances of art perception, we restricted the set of stimuli to this period in time because, as stated earlier, we expect these artworks to play more deliberately with *SeIns*. Furthermore, we asked whether the experience would differ between artworks, some inducing one of the variants to a greater extent than the others. We asked participants to describe the "Mehrdeutigkeit" of a range of artworks (a concept used in the German language for "plurality of meaning") and classified the descriptions along a set of six *post-hoc* criteria. A cluster analysis along these criteria revealed four clusters of artworks primarily inducing one variant of *SeIns* each.

2 Methods

2.1 Participants

Forty-three participants voluntarily took part in the study (25 female and 18 male; $M_{\text{age}}=24.6$ years, $SD_{\text{age}}=5.8$; range_{age}=18-41 years); most of them were students of Psychology and gained course credit for participation; others were contacted via word-of-mouth. A *Snellen*

Eye chart test and a sub set of the *Ishihara* color cards assured that all of them had normal or corrected-to-normal vision and normal color vision. They were naïve to the purpose of the study and did not have any training in art or art history besides regular school education. Before the experiment, participants gave written informed consent to participating in the study and they were informed about the aims of the study after the experiment.

2.2 Apparatus and stimuli

Photographs of 17 modern and contemporary artworks in original color were shown on an LG W2220P screen with a 47 cm × 30 cm screen size at a resolution of 1,680 × 1,050 pixels (see Table 1 for the list of artworks). For each artwork, we also created an additional paper-mounted version. Participants sat approximately 60 cm away from the screen. Stimuli were selected based on an excessive search through books and catalogues in an art specific library as well as via a free internet-based search. Criteria for selection were an assumed high potential to evoke *SeIns* as well as the inclusion of diverse methods like painting, photography, collage, object and sculpture.

[please insert Table 1 about here]

2.3 Procedure

Data reported in the present study was assessed in the context of a previously reported study (X, Y, & Z, 2015) consisting of two phases: the first phase comprised ratings on liking, interest, powerfulness of affect, perceptual affect, and cognitive affect (all in this order per stimulus) and the second phase ratings on *Mehrdeutigkeit*, descriptions of *Mehrdeutigkeit*, ratings of the solvability of ambiguity, descriptions of insights, and ratings of strength of

insights (in this order per stimulus). The previous article exclusively reported the quantitative data. Now, we will exclusively refer to qualitative data assessed in the second phase immediately after the rating of ambiguity, descriptions of *Mehrdeutigkeit* (see Figure 2). Participants were asked to describe the *Mehrdeutigkeit* of each artwork in a free-typed report while being presented with it on-screen as well as in a paper-mounted version to allow for a more convenient visual exploration, and to exclude the potential restrictions of a purely digital presentation. Each of the 17 artworks was presented once in a fixed order without time constraints. After each description, the participants had the opportunity to take a break.

[please insert Figure 2 about here]

2.4 Results and discussion

To extract different variants of *SeIns* inherent to the participants' descriptions, we employed a *k*-means cluster analysis along the set of six criteria. These criteria were defined by the authors after an exploration of the descriptions. They all mark critical aspects of and differences among the reports, some of them also describe important qualities of the theoretically elaborated variants of *SeIns* and allow for important differentiations between them (switching for multistability, association for indeterminacy, and emergence for experience of hidden images). In order to increase the objectivity of classifying the participants' reports, three independent raters characterized each description of an artwork's *Mehrdeutigkeit* along this set of six criteria which were explicated to them by a definition and fictitious examples not stemming from the actual descriptions (see Table 2). We then used a *k*-means cluster analysis on the mean classifications regarding the criteria for each artwork to see whether they exemplify specific variants of *SeIns*. This algorithm first chooses cluster

centers randomly and updates them by minimizing the within-cluster sum of squared Euclidean distances, meaning the sum of distances between the cluster centers and each object (here specifics of descriptions for each artwork). This way we were able to reveal characteristics shared by groups of artworks (the clusters) via an empirical approach; predefinitions that might have had a potential influence on the resulting clusters were reduced to the necessary definition of criteria along which reports were evaluated. Statistical analyses were performed using the statistical software *R* (version 3.2.2.) and *R Studio* (version 0.99.484), an integrated development environment (IDE) for *R* (both open source).

First, the three raters categorized each description of *Mehrdeutigkeit* of an artwork (43 participants \times 17 artworks yielding 731 descriptions in total) concerning a set of six different criteria after having been explained the according definitions as provided in Table 2. The raters were free to assign one description to a) one category, b) to various different categories or c) to no category at all. Consequently 13,158 assignments (731 descriptions \times 6 categories \times 3 raters) were maximally possible, of which the three raters conducted 2,767 assignments in total. In 219 cases all of them assigned a description to the same category (657 assignments), in 506 cases two of the assignments were in accordance (1,012 assignments). All other cases (1,098 assignments) in which only one of the raters assigned a description to a certain category were excluded from further analyses so that the data set contained only those cases in which there was agreement among at least two of the three raters. Of the 2,767 assignments in total these were 1,669 assignments (657 equivalent assignments by 3 raters + 1,012 equivalent assignments by 2 raters), resulting in 60.3 % agreement of at least 2 raters. These data were aggregated so that each stimulus was described by probability of assignment for every category: if all of the participants had described a switch in interpretation when perceiving artwork A (and the majority of raters classified this accordingly,) this number

would have been 1.0. If half of them had described it in that way, it would have been 0.5 and if none had the number would have been 0.0.

[please insert Table 2 about here]

As the method of *k*-means uses a preset number of clusters we had to identify the most appropriate number beforehand. To do so we used three criteria: first, we compared the within-cluster squared Euclidean distances as a measure of the fit between cases and clusters. An “elbow” within the row of changes of this value between different numbers of clusters can be interpreted as an indicator that this specific change in the number of clusters does not yield substantial information, so it is utilized to determine the minimal number of clusters still adequately describing the data. Based on the graphical inspection of the squared distances in Figure 3, we identified cluster numbers 3, 4 and 5 as the lowest numbers still providing acceptable differences. As an additional criterion, we aimed at describing the data by as few clusters as possible given that we utilized a quite limited set of 17 artworks in our study (due to the potential side effects which a larger set might have had on the participants’ concentration and detail of their descriptions). Based on a third criterion, we decided to make the cut at four clusters though: a comparison of the amount of explained variance (between-clusters sum of squares/total sum of squares) revealed that three clusters explain only 46 % of the data’s variance while four clusters yield 60 % of explained variance.

[please insert Figure 3 about here]

We performed a *k*-means analysis on the mean classification per stimulus with four clusters in *R*; the according function *kmeans* uses an algorithm by Hartigan and Wong (1979). Table 3 reveals the cluster centers to which the artworks can be grouped.

[please insert Table 3 about here]

The sum of squares of Euclidean distances between the scores of each stimulus to those of the cluster means were 0.38 for Cluster 1, 0.23 for Cluster 2, 0.22 for Cluster 3 and 0.0 for Cluster 4 (as there was only one artwork applied to this cluster). Figure 4 maps the scores of all artworks on two principle components axes and reveals how they are grouped into clusters. Exemplary artworks for each cluster are displayed to clarify their characteristics with regard to the variant of *SeIns* (see Table 4):

[please insert Figure 4 about here]

In the following we try to characterize the four revealed clusters on the basis of the respective categories they are associated with plus the analysis of the concrete pictures that were assigned to the regarding clusters.

2.4.1 Cluster 1 “integrative blend”

Descriptions of artworks grouped in this cluster scored high on the criteria of “association” and—in contrast to Cluster 3—also on “blend”. Looking at the artworks as well as how participants described them, we are able to characterize this difference to cluster 3 in more detail. All of the artworks in this cluster blend interpretations, associations or dichotomies

between qualities of material and content, though they do not allow patterns to be disentangled from each other (e.g., Hans Bellmer's "Transfert des Sens" from the year 1960), use the technique of collage (e.g., Teige's "Collage 374" from the year 1951), or combine fluent form and massive material (e.g., Tony Cragg's "Can-Can" from the year 2000). Meret Oppenheim's (1938) "Steinfrau", for instance, allows for the arrangement of stones to be associated with the shape of a woman without giving a clear interpretation of either of them (stone or woman) and Tony Cragg's sculpture "Can-Can" from the year 2000 was described as semantically instable based on the indeterminacy of detectable patterns as well as on the contrast between organic or fluent form and inflexible material. Furthermore, in some cases, participants explored the blend in an integrative manner. For instance, Magritte's "Les Jours Gigantesques" from the year 1928 shows a woman in a position being interpreted as either joyful or aversive. Within her silhouette and inseparable from her body, a man is depicted. Several descriptions focus on this blend and interpret it as a kind of intrusiveness; the woman would either fight parts of herself or a male attacker. Kaplan and Kris (1948) speak of "integrative ambiguity" when several meanings build one complex meaning together (in the realm of language). We might refer this to the case when the conflict of the depiction of a man within the silhouette of a woman gains meaning itself if interpreted as an image of intrusiveness. We therefore suggest that Cluster 1 refers to a variant of *SeIns* that is characterized by blends which are often elaborated in such a way that meaning is formed by integrating the blended elements.

2.4.2 Cluster 2 "multistability"

Four artworks were grouped to the cluster "multistability" (Cluster 2). This case is rather clear: the descriptions score highly with regard to the category of "switching" and all

according artworks offer at least two determinate interpretations—Wei Liu’s photograph “It looks like a landscape” from the year 2004 displays body parts which were identified as such only after a while, because the first association for many observers was a mountain landscape (one description was, for instance: “First mountain landscape, then at a closer look you detect partially naked men who are bending over”, translated by the authors). Gober’s “Untitled” from the year 1990 was interpreted as a male torso or as a bag (see Table 4).

2.4.3 Cluster 3 “indeterminacy”

Descriptions of artworks assigned to this cluster were mainly categorized as describing associations. The difference between this variant of *SeIns* (Cluster 3) compared to Cluster 1 “integrative blend” and Cluster 2 “multistability” is that descriptions of Cluster 3 do contain suggestions of interpretation rather than conflicting blends of interpretations or multiple but determinate interpretations. Descriptions of this cluster circle around the challenge of identifying depicted objects (like the ear- or bone-like structures in Bellmer’s “Ossature de bassin” from the year 1960, see Table 4).

2.4.4 Cluster 4 “contradiction to perceptual habits”

Only one artwork was clearly assignable to the fourth cluster. Meret Openheim’s “Frühstück in Pelz” from the year 1936 was the only artwork of the selection which played primarily with an irritation of the functional qualities of an everyday object. Whereas Ready-Mades—everyday objects exhibited in an art context—typically render familiar objects in a semantically instable way via a context shift, “Frühstück in Pelz” causes a prediction error by combining the object with very unusual material, which makes the usage of the object impossible or at least inconvenient. Participants mostly referred to this irritation of the

familiar function of the object in their reports. Furthermore the experienced contradiction to the perceiver's (perceptual) habits seems to be intensified by a cognitive simulation of the action commonly linked to the object, as some of the descriptions suggest (e.g., "When I look at the whole thing I already literally feel the hairs in my mouth and on my tongue"). Such descriptions exemplify the strong link between perception and action via predictions—as discussed in the introduction.

[please insert Table 4 about here]

3 General discussion

We extracted four variants of *SeIns* in artworks from the 20th and 21st centuries based on empirical descriptions of "Mehrdeutigkeit" (a concept used in the German language for "plurality of meaning"): (1) integrative blend, (2) multistability, (3) indeterminacy, and (4) contradiction to habits. In contrast to the theoretical approach applied earlier (X & Z, 2016) we aimed at extracting variants of experiences of *SeIns* by applying an empirical approach based on qualitative data.

The results demonstrate a difference between multistability and indeterminacy with regard to experiential qualities and furthermore suggest an extension by two additional variants of *SeIns*. As mentioned earlier, it is evident that these variants are not disjunctive; this becomes very clear when looking at the overlaps of categorizations as depicted in Table 3. And of course, one artwork can induce several variants of *SeIns*, not only for different persons but also for one person. Subtle but relevant nuances in the experiential descriptions naturally got cut out along with those descriptions falling within the blurry boundaries of categories due to the classification procedure: Hans Bellmer's "Transfert des Sens", for instance, made many observers identify several female shapes entangled with each other, but

reminded one person “at the same time (...) of a constellation of stars.” (translated by the authors). Such multilayered *SeIns* and insights might form an important part of an artwork’s aesthetic impact, whereas its complex and subjective nature runs counter to methods of clustering.

There are several additional challenges to the approach that might provide at least partial explanations for the lack of two hypothesized clusters from the results, dichotomy and experience of hidden images: first, we focused on a very narrow selection of art works from the 20th and 21th centuries comprising not more than 17 artworks to guarantee the quality of the assessed descriptions. By that we clearly reduced the variety of possible clusters. Furthermore, we are used to perceiving representations, and people probably rarely mention, for instance, their dual nature being material and image at the same time. This can be easily demonstrated by pointing to the multifaceted nature of all the representations used in this study: participants encountered a digital representation of photographs of either paintings, objects, or—again—photographs representing a certain composition of elements that at times represent identifiable illusory content. Only at rare occasions (as for instance when looking at Figure 1B) are we made aware of such a dichotomy—the multiplicity of perceptual levels which we can focus to. While being an important variant describable at a conceptual level, we might state that this variant of *SeIns* is often present but rarely consciously noticed; reflections about such qualities might be induced by specific artworks or in certain contexts only. We used quite a limited number of stimuli in our study as any prolongation of the study by a larger set would have negatively influenced the quality and detail of participants’ reports. It would be interesting to further investigate whether people might actually describe a dichotomy when utilizing a larger set of works and the actual artworks themselves as the fact that we showed representations (digital images and paperboard prints) might have on one

hand added dichotomy but on the other might also have strongly impaired the viewers' awareness of material characteristics of the works of art and thereby of their original material/composition/image dichotomy. A few cases of descriptions that might be related to dichotomy should be mentioned in this context, even if not consistently applicable to a cluster of artworks: e.g., the description of the integrative blend of material and shape in Tony Cragg's (2000) "Can-Can" was sometimes described as a consequence of the interlocking between qualities of the material (inflexible, heavy) and qualities of the shape (fluent, organic). These notions are a clear indication that we do not necessarily separate perception of material from perception of content and switch between them as in multistability, but rather that the effect of an artwork is strongly dependent on the *combination* of material, composition and content. Lev Vygotsky (1976) similarly pointed out that one and the same figure will appear very differently if made of paper than if made of bronze. Similarly, a specific aesthetic effect would be induced when the natural rhythm of words in a poem differs from the poetic meter.

An additional challenge when analyzing written experiential reports is that a lot of the dynamics of experience are lost. Such dynamics are especially relevant to the variant of experience of hidden images (as just recently shown by X, Y, & Z, 2015 as well as by Weth, Raab, & Carbon, 2015): for instance, it is likely that many participants detected more than two women in Hans Bellmer's "Transfert des Sens" from the year 1966 only after concentrated elaboration. Still, they might not mention the intermediate states with great detail in the descriptions (one exception is the following participant's note "The longer you look at the picture the more details you notice", translated by the authors). Our findings are therefore far from complete: not only might a change in detection during a visual search or an insight into a new semantic level change the degree and variant of *SeIns* of an image, but

changes in focus and position might also be crucial: Mona Lisa's smile, for instance, is not ambiguous per se; it *becomes* ambiguous due to the change of focus (Hesslinger, Görlitz, & Carbon, 2012), or a specific saccade (see Bohrn, Carbon, & Hutzler, 2010).

Very generally, it is evident that experiential reports are themselves semantically instable and are only crude cues for retracing experiential qualities. This point is clearly reflected in the huge amount of descriptions which were not consistently classifiable (e.g., the 1,098 cases in which only one of the raters assigned a description to a certain category and which were therefore excluded from further analyses). Furthermore, we have to be very clear about the fact that the perception and elaboration of these paintings, as well as the interpretation of the corresponding reports, might be strongly influenced by the historic and cultural context especially due to the big changes in perception and appreciation of art over time: Whereas, for instance, some of Edouard Manet's and Claude Monet's paintings were vigorously attacked when first exhibited in the *Salon de Paris* (see, e.g., King, 2008 for a narrative historic description of the change in their reception), they are widely accepted in the Western cultural canon nowadays (and even decorate everyday accessories)—see Carbon (2011) for an explanation of this effect based on adaptation. It is evident that our perception of *SeIns* is strongly dependent on the experience-fed models upon which our predictions are based. In addition, the perception and appreciation of *SeIns* might be strongly related to a tolerance to ambiguity (e.g., X, Y, & Z, 2015) and means of social distinction (as was famously discussed by Bourdieu, 1984): Getting involved in describing very challenging aspects of an artwork might nowadays symbolize cultural competence.

While the collection and analysis of typed reports evidently attributed blind spots to dichotomous qualities as well as to dynamics of perception, it revealed another—unexpected—variant of *SeIns*. Kaplan and Kris (1948) already specified several ways in

which multiple interpretations can relate to each other; for instance, they can be disjunctive but also additive or even integrative. What we labelled as “integrative blend” (referring to Cluster 1) was indeed a pattern of classifications of descriptions which points to experiences of meaning *within* contradictions. This variant might be most fragile and fuzzy; but we need to consider that meaning might not equal visual determinacy, a clearly and univocally identifiable Gestalt. Thinking, for instance, of metaphors, irony and sarcasm, we can imagine a whole lot more cases of meaningfulness which might even comprise contradictions. It is not entirely clear to this point how predictive coding might be able to account for these compounds of new meaning out of contradictory predictions. As we noted earlier (X & Z, 2016), the androgynous fashion style of Berlin women in the 1920s once clashed with perceptual habits but now defines a specific style. While “determinate” from nowadays perspective, we might still feel the slight oscillations of its androgynous elements that define it in the first place. The descriptions collected in the context of this study once more point to the dynamics and multifaceted nature of sense making that need to be taken into consideration when thinking in terms of matches and mismatches of predictions with stimulations. This issue is of big relevance as well when asking why we don’t avoid stimulation as such to maximally reduce surprises (so called ‘dark room problem’): humans predict dynamic environments and are rather surprised by static ones (Friston et al., 2012) as well as they might predict novelty when entering an exhibition and might be surprised by finding familiar objects (as with Ready-Mades, X & Y, 2016). Surprise in these terms is always relative to these model-based predictions (Friston et al., 2012). Speculative as this idea might be, we suggest that integrative blends might be an outstanding case of *SeIns* that integrates mismatches of predictions into matches on higher levels of prediction in a similar way like the dynamics of a situation might pose mismatches on low levels of prediction but

matches to predictions of dynamic stimulation. A further unexpected cluster, contradiction to habits, resulted from the analysis. Although any generalizability is strongly limited by the fact that the cluster has been applied to one artwork only, it points to an important quality of all encounters with *SeIns*: context and interaction are crucial determinants of the evocation of predictions and prediction errors. As mentioned above, Ready-Mades nicely exemplify the relevance of context to *SeIns*; a determinate and familiar object gains new qualities and functions in an art context. Interaction is equally interesting to perception science as it points to the flexibility of meaning and its dependence on the relationship between environment and the internal dynamics of the perceiver (Di Paolo et al., 2010). Artifacts are not (just) defined by their form but by the way we use them, that is by their experience-based function. A change in usage or interaction, as is made in pretend play as well as when material gains new functions in art, might also change the meaning of the respective object (e.g., a hairbrush can become a microphone when we sing into it). According to Di Paolo et al. (2010) this *reenaction* of meaning might give a clue to the fact that meaning is continuously created and changed by interaction. Also within the predictive coding approach actions are closely linked to perception: “We predict the sensory consequences of our own action and this brings the actions about” (Clark, 2015, p. 7) and at the same time “descending signals are already (just as in the perceptual case) in the business of predicting sensory (both proprioceptive and exteroceptive) consequences” (Clark, 2015, p. 9). The given examples underline that like this we are constantly engaged in predicting upcoming states and act in order to instantiate some of these states in a flow of perception-action loops. This flexibility of meaning also plays an important role for appreciation and pleasure, concretely with regard to rewarding insights (X & Z, 2013; X, Y, & Z, 2015) and related loops of hypothesis testing (e.g., Carbon & Jakesch, 2013; Leder et al., 2004). Again, Ready-Mades, such as Duchamp’s famous “Fountain” (an

industrialized manufactured urinal, exhibited in 1917), offer a tangible illustration hereof: by presenting an everyday object in an art exhibition, the artist shifts the context, which induces a re-enactment or re-definition of the object's meaning by the perceiver. We would probably hesitate to use the urinal in its everyday function when it is presented in a museum; and if we followed the example of various artists who did not hesitate to do so (Ingram, 2016), the meaning of the object and of the act itself would indeed not be identical with their corresponding meaning in the context of a bathroom. It is thus evident that every object has, due to dynamics in context and interaction, the potential to induce the experience of *SeIns*, two aspects which were confined by the context of a laboratory in our study and which call for further assessments, e.g., in the art-specific context of exhibitions.

4. Conclusion

Artworks can point us to the fact that perception always (pro-)actively deals with *SeIns* and does so in various ways. To investigate these special cases of sense making, we need to start with a differentiation of according experiences—even if no clear-cut categories might emerge at first. We provided an initial, empirically-based classification of the experience of *SeIns* in art revealing four clusters of artworks that most consistently induced one of the following variants of *SeIns*: integrative blend, multistability, indeterminacy, or contradiction to habits. These variants certainly describe only a restricted part of possible characteristics of experiences with *SeIns* which have to be further elaborated by future attempts. We discussed methodological limitations of the applied method like familiarity with the dichotomous quality of representation, limitation of the number of stimuli and the reduction of dynamics that might be related to the fact that two theoretically considered variants, dichotomy and experience of hidden images, were not consistently described by participants. Promising

further variants might be related to context and interaction, important determinants for the experience of *SeIns*. Not least, the concept of meaningfulness has to be further elaborated based on the question of whether it can comprise a plurality of meanings in an integrative way.

Acknowledgements

We would like to thank X, X, X, and X for assistance regarding the conductance of the study and the classification of experiential reports. Furthermore, we would like to thank X for proofreading the manuscript. We also want to thank Pablo Tinio for editing this manuscript and two reviewers who improved and sharpened our conceptual ideas put forward within this manuscript.

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Table 1

Artworks used as stimuli (displayed as photographs and handed as paper-mounted versions).

Artist	Year of creation	Title
Bellmer, H.	1960	<i>Ossature de bassin</i>
Bellmer, H.	1966	<i>Transfert des Sens</i>
Boden, B.	1966	<i>Kleiner Mann im Ohr</i>
Breitling, G.	1966	<i>Maleditia Calumnia</i>
Collien, P.	1964	<i>Daphne</i>
Coste, C.	2007	<i>Corps viscéral V</i>
Cragg, T.	2000	<i>Can-Can</i>
Gober, R.	1990	<i>Untitled</i>
Liu, W.	2004	<i>It looks like a landscape</i>
Maar, D.	1930	<i>Doppelporträt mit Huteffekt</i>
Magritte, R.	1928	<i>Les Jours Gigantesques</i>
Miller, L.	1937	<i>Raumportrait Ägypten</i>
Oppenheim, M.	1936	<i>Frühstück in Pelz</i>
Oppenheim, M.	1938	<i>Steinfrau</i>
Táborský, H.	1933	<i>Self portrait 2</i>
Teige, K.	1951	<i>Collage 374</i>
Thiele, P.	1984	<i>Der große Bruder</i>

Table 2.

Categories to which the raters assigned participants' verbal reports.

Category	Switch	Blend	Association	Emergence	Uncertainty	Contrad. to habits
Definition	Switch in interpretation of the same elements	Synchrony of contradictory meanings or materials, not solvable	No identification or solution but associations	Meaning or identification evolves with time	Meaning stays unclear	Contradictions to habits, be it perceptual or function-related
Examples	"...first [x] and then [y]" or "... [x] or [y]"	"two [x] in one" or "round and squared" or "simultaneous..."	"I associate [x] with [y]" or questions like "not clear, but like [x]?"	If it gets clear that something new was detected; "I see [x] just now" or "at beginning nothing... then [x]"	Questioning intention; "I don't understand, recognize"	errors in depiction, form, or material; "not usable"; "unrealistic/unusual composition" or "material does not fit to effect"

Table 3.

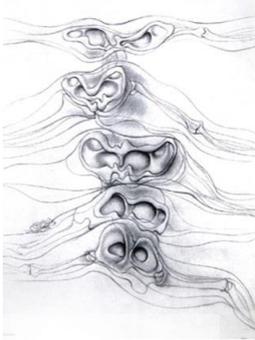
Four clusters revealed by a k-means cluster analysis on the mean classification of descriptions per stimulus. Bold numbers indicate the respective highest value of each cluster.

	Switching	Blend	Associa- tion	Emer- gence	Uncertain- ty	Contrad. to habits
Cluster 1 <i>Integrative blend</i>	.08	.20	.36	.09	.17	.17
Cluster 2 <i>Multistability</i>	.40	.17	.16	.05	.12	.11
Cluster 3 <i>Indeterminacy</i>	.07	.05	.59	.02	.27	.32
Cluster 4 <i>Contradiction to habits</i>	.04	.04	.04	.00	.00	.70

Table 4.

Examples of participants' descriptions of Mehrdeutigkeit (unspecific typos have been corrected for the sake of readability).

Artwork	Description (translated by the authors)
	<p><i>Cluster 1 Integrative blend</i> Tony Cragg (2000). "Can-Can".</p> <p>"I recognize first two metal objects in bronze that have a beautiful curved shape. The metal, which should actually be hard to deform appears very light and delicate but massive at the same time."</p> <p>"I see parts of a brass instrument, a motorbike sidecar, and a horse-racing wagon, each doubled; but of each mainly only rudiments are detectable and nothing determinate."</p> <p>"A kind of pipe made out of brass that is somehow bound but separated."</p>
	<p><i>Cluster 1 Integrative blend</i> Hans Bellmer (1960). "Transfert des Sens".</p> <p>"Many women, the foot of one is the head of the other (...) at the same time memory of a constellation of stars."</p> <p>"After the first count 6 are detectable which are not determinately separable from each other but rather melt with each other."</p> <p>"The longer you look at the picture the more details you notice."</p>
	<p><i>Cluster 1 Integrative blend</i> René Magritte. (1928). "Les Jours Gigantesques".</p> <p>"Ambiguities are rather of an interpretative nature: Rape, fight against parts of one's own soul/personality?"</p> <p>"The shadow of the woman's body transforms into another figure, which builds itself within the borders of the woman's body. As if it would be an inseparable part of the woman, of which she actually wants to detach herself."</p> <p>"Is the woman in difficulty? The man just a result of thoughts or actually existent? Appears frightening."</p>



Cluster 3 Indeterminacy
Hans Bellmer (1960). "Ossature de bassin".

"I recognize something bone-like that changes from the top to the bottom of the image. You could recognize the cutout of a deformed spine but also a map showing the courses of a river."

"Five forms, similar to each other, are drawn that are reminiscent of joints between bones because of their respective context to the left and right. Somehow they also resemble distorted and reciprocally mirrored ears. This similarity is lost downwards, so that the entities are reminiscent more of joints, which would actually make more sense than one ear between bones."



Cluster 2 Multistability.
Robert Gober (1990). "Untitled".

Photograph by Sharona Gott, cropped ("Robert Gober - Untitled human chest", shot in 2009, <https://www.flickr.com/photos/gottshar/3557904176>), licensed under creative commons.*

"You can see it as what it is, a bag on which something was painted, but it evokes the association of a male torso or a male chest."

"On one hand a male torso; on the other hand the object looks like a bag of concrete or packaged meat."

"Something pure (wax) is finally converted into a hairy male torso."

"Suggestion of a male breast on a plastic bag, by that contradiction between human and inorganic Gestalt."



Cluster 4 Contradiction to habits.

Meret Oppenheim (1936). "Frühstück in Pelz".

Photograph by Antonio Campoy ("taza peluda", shot in 2008, <https://www.flickr.com/photos/viviendoenlaerapop/2830934550>), licensed under creative commons.*

"A familiar fabric (fur) is transformed into an unfamiliar shape (cup)."

"No ambiguities on the visual level, determinately identifiable as tea service. Ambiguity on a functional level, though: 1. Nobody likes to drink out of a hairy cup because unsanitary and risk of suffocation from hairs and 2. Cleansing of a hairy tea service is not practicable."

"That is an actual article of daily use; that is why the contradictions are very very impressive. When I look at the whole thing I already literally feel the hairs in my mouth and on my tongue, which I find of course very, very inconvenient."

*Note: Due to license issues we have to show a photograph of this specific work that is different from the one originally used as stimulus material in the study.



A



B

A. *Multistability*: a so-called “Rubin-Vase” displaying a vase or two facial profiles, dependent on the respective interpretation (the first Rubin-Vase was published around 1915 by Edgar Rubin).

B. *Dichotomy*: Macků, M. (1989). “Gellage No. 6” [photograph]. Retrieved from <http://www.michal-macku.eu/image/122>.



C

C. *Visual indeterminacy/semantic potentiality*: Tony Cragg (2001). “Early Forms” [sculpture] (2001, Photograph by Gerardus from 2008, Wikimedia commons).



D

D. *Experience of hidden images*: adaptation from original hidden image by Karl Dallenbach (1951).

Figure 1A-D. Examples of four variants of *SeIns*.

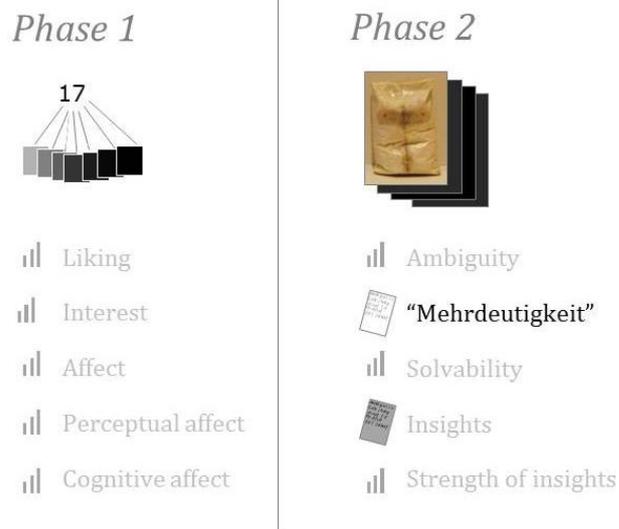


Figure 2. Procedure of the study. Note that in the present article we exclusively present an analysis of the qualitative data assessed in the second phase on *Mehrdeutigkeit*. Results of all other assessments (in grey) were reported in X, Y, and Z (2015).

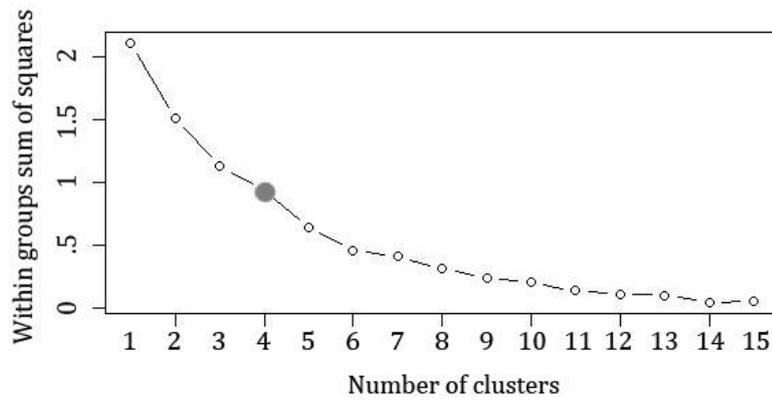


Figure 3. Within-cluster sum of squared Euclidean distances for different numbers of clusters. Selected number of clusters for *k*-means analysis is marked in grey.

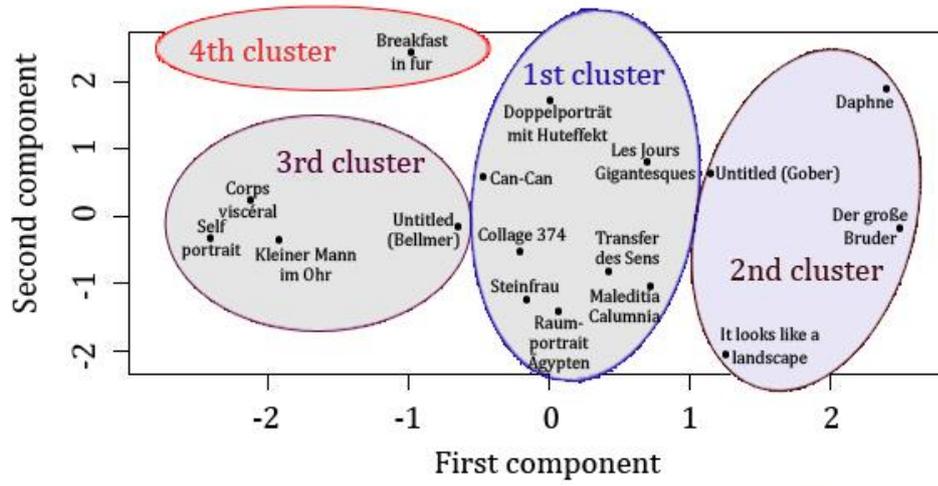


Figure 4. Overview on clustered artworks by 2 component axes.