A picture is worth a thousand words: Emotion recognition and qualitative impressions of Armand Henrion's self-portraits displaying mixed emotions

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Abstract

Researchers often study recognition of single emotions. Realistic faces, however, display several emotions in quick sequence or at the same time (mixed emotions). This likely causes interindividual differences in peoples' reactions to the same situations and stimuli. We studied such differences using 11 self-portraits painted by Armand Henrion (1875-1958), in which he depicts himself as a Pierrot clown displaying different affective states. Thirty-eight adult participants (15 men) saw the self-portraits twice (one brief, then one unlimited presentation). After the first brief presentation (1-2 seconds), participants i) selected the most prominent emotion (out of 20) and ii) rated the intensity of this emotion. After the second unlimited presentation, participants performed the same selections and ratings before describing what could have caused the facial expression (qualitative data). Results confirmed that Armand Henrion's self-portraits display mixed emotions: participants selected diverse emotions, sometimes differing in valence. Participants selected comparable emotions between presentations but rated them as more intense the second time. The qualitative answers complemented the selected emotions. For instance, when some participants chose "disgust", while others chose "sadness" for the same self-portrait, the qualitative answer matched this choice, indicating that the character either "ate or drank something they don't like" or "lost something or someone". We conclude that Armand Henrion's self-portraits provide a promising set of facial stimuli to investigate mixed emotions. Each self-portrait displays diverse emotions of varying intensities and are realistic because they could all be linked to possible situations.

Keywords: art, aesthetics, affect, emotion, facial expressions, mixed emotions, Ekman's faces

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coordinated the Helmut Klewan's collection and kindly provided high-quality scans of Armand Henrion's self-portraits for scientific use. We are grateful to Christopher Thorstenson for proofreading our manuscript and to all our participants for taking part in this study. No conflicts of interest are declared.

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Data analyses: LM, CC, YS, DJ

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1. Introduction

Humans are highly social. We constantly interact with others around us, whether in the context of our family, friends, neighbours, or when shopping or at the workplace. To handle these different social interactions efficiently, we communicate verbally and non-verbally (Hadley et al., 2022). For non-verbal communication, we rely on body postures and movements, often conveying intentions as well as inner mental states (Hall et al., 2019). Taking such information into account facilitates interpersonal interaction. Imagine a client looking around your shop. You approach them to determine if they need your help. You are likely to consider their facial and bodily expressions to decide if and how to address them. Their facial expression might express either confusion or curiosity. In the former case, the client might be searching for something in particular, while in the latter case, they might be simply looking around for inspiration. These two cases require different actions: one to help the client find an item, and one to keep distance and let the client roam around your shop, whilst remaining discretely available for potential clarifications. While bodily expressions might be more informative from a distance, once sufficiently close to another person, facial expressions carry key affective information.

Emotion recognition from faces has been (Ekman and Oster, 1979; Hunt, 1941; Russell et al., 2003) and remains (Canal et al., 2022; Jack and Schyns, 2015; Jia et al., 2021; Keltner et al., 2019) intensively studied. Early studies on face images suggested six prototypical facial expressions – happiness, anger, fear, disgust, surprise, and sadness (Ekman et al., 1969; Elfenbein and Ambady, 2002). More recently, studies have been refining this notion by either augmenting the number of prototypical facial expressions (e.g., Cowen and Keltner, 2019) or by reducing the number to identify cross-cultural universals (e.g., Gendron et al., 2018; Jack et al., 2016). Furthermore, emotional expressions are rarely static or clear-cut. Rather, several emotions are often present at the same time or in a quick temporal sequence, leading to so-called mixed emotions (Charles et al., 2017).

There exist several approaches to studying mixed emotions. One approach used to determine facial stimuli of mixed emotions is to ask actors to enact emotional situations (Bänziger et al., 2012). Other

approaches include extracting emotional expressions from film clips (Cowen and Keltner, 2019), or using chimeric faces that combine split halves of the same face displaying two different emotional expressions (e.g., Levy et al., 1983; Tanaka et al., 2012; Watling and Bourne, 2007). With more recent technological advancements, it is possible to blend two or more photos of facial expressions to create new intermediate expressions (e.g., Fang et al., 2018; Kaminska et al., 2020). It is also now possible to generate entirely fictional faces, and systematically manipulate their expressions (Jack and Schyns, 2015; Krumhuber et al., 2012). The actor-posed faces or naturalistic expressions offer less systematic control over stimuli than computer-generated faces. The latter, however, might lead to less realistic looking faces (Philip et al., 2018). Despite this wide range of approaches, visual artwork has been largely neglected so far.

Armand F. J. Henrion (1875-1958) was a Belgian artist who spent his lifetime painting self-portraits as a Pierrot clown (see Figure 1 for examples). As of today, over 2,000 such self-portraits are known to exist, most in private collections (personal contact at the museum). The original Pierrot clown was introduced by Molière in his play, Don Juan. There, Pierrot is a sad clown, in love with the beautiful servant Columbina. Yet, Columbina breaks his heart leaving him for Harlequin. Pierrot has become the archetype of a lonely naïve fool, who fights his cynicism with humour. Important to our study, Pierrot's facial skin is always covered in white makeup. In Armand Henrion's versions, he always wears a head bonnet, varying in colour. Armand Henrion, as Pierrot, displays distinct facial expressions across his paintings. These expressions are not easy to identify as they seem ambiguous and theatrically exaggerated.

We encountered a selection of Armand Henrion's context-free self-portraits in an exhibition and were impressed by the different emotional interpretations of each self-portrait. We felt the self-portraits could be of value in their story-telling potential. In the current study, we investigated whether these self-portraits display systematic emotion expressions and thus could be promising in testing mixed or ambiguous emotions here and in future studies. To this end, we asked adult participants to select

emotions and rate the emotion intensities for 11 self-portraits. In addition, participants described situations that could explain the expression displayed in the self-portraits. We expected participants to match diverse emotions, even of different valence, to each self-portrait and that this diversity would be greater than the diversity for control faces (Ekman's facial stimuli of basic emotions; Ekman, 1993; Ekman et al., 1969; Ekman and Friesen, 1971). We predicted qualitative descriptions of the situations to compliment and clarify participants' emotion choices.

2. Material and Method

2.1. Participants

We recruited 38 adult volunteers (15 men, M_{age} = 23.5 years, SD_{age} = 2.9 years, range = 20-31 years). Some participants (n = 26, 11 men) were first year psychology students at our local university and were compensated with course credit. The remaining participants were recruited via personal contact and participated voluntarily without remuneration. Participants' vision was normal or corrected to normal with glasses or lenses. No participant was colour-blind, as verified using the Ishihara colour vision test (Ishihara, 1993). The study was conducted in Switzerland using the French language.

2.2. Emotion Stimuli

We used 11 self-portraits of the Belgian painter Armand Henrion (Figure 1). These were high-quality digital scans of the original self-portraits provided by the Helmut Klewan's collection at the Belvedere Museum in Vienna, Austria in 2017 (https://www.belvedere.at/en/klewan-collection-0; permanent copy of the website: https://osf.io/5hgde). The collection owns the original self-portraits, or at least did so at that time. Formal permission was granted to use the digital scans for scientific studies. All self-portraits show Armand Henrion with white makeup on his face and wearing a head bonnet of different colours. The self-portraits represent a range of diverse emotion expressions. We presented

these self-portraits as printed, laminated cards (21.0 x 14.7 cm; A5). The stimuli can be accessed here: https://osf.io/mf9t5/

We further prepared six printed, laminated cards of faces, originally created by Ekman in greyscale (Ekman, 1993; Ekman et al., 1969), displaying happiness, sadness, disgust, anger, fear, or surprise (see Figure 4). Ekman's faces have been frequently used in research to test emotion recognition (e.g., Ruffman et al., 2008).

2.3. Emotion Assessment

We assessed emotions using the paper version of the Geneva Emotion Wheel (GEW, version 3.0; Figure 2; Scherer, 2005; Scherer et al., 2013). The wheel is organized along two axes with emotions similar in valence and power positioned close to each other. The horizontal axis represents valence: positive emotions on the right and negative emotions on the left. The vertical axis represents power: high power emotions on the top and low power emotions on the bottom. Emotion intensity is defined by the five circles of different sizes, with size increasing from the centre to the perimeter. The smallest circle indicates the weakest emotion intensity (coded as 1) and the largest one indicates the strongest emotion intensity (coded as 5). The small squares closest to the centre of the wheel indicate no association. Options "no emotion" and "different emotion" appear in the centre of the wheel and participants are invited to use them.

We slightly modified the original GEW by replacing *relief* with *surprise.* In our preliminary investigation, individuals often mentioned *surprise* for some of the self-portraits. More generally, *surprise* is a prominent facial expression, being one of the basic emotions and frequently used in face recognition tasks (Ekman, 1993; Levenson, 2011). We decided to omit *relief* and replace it with *surprise* to keep the overall number of positive and negative emotions equal.

The French version of the GEW is available on the Swiss Centre for Affective Sciences website (http://www.affective-sciences.org/gew). The original French version of the GEW (with *relief* instead of *surprise*) has been used in previous studies (e.g., Gillioz et al., 2016; Jonauskaite et al., 2020a, 2020b, 2019).

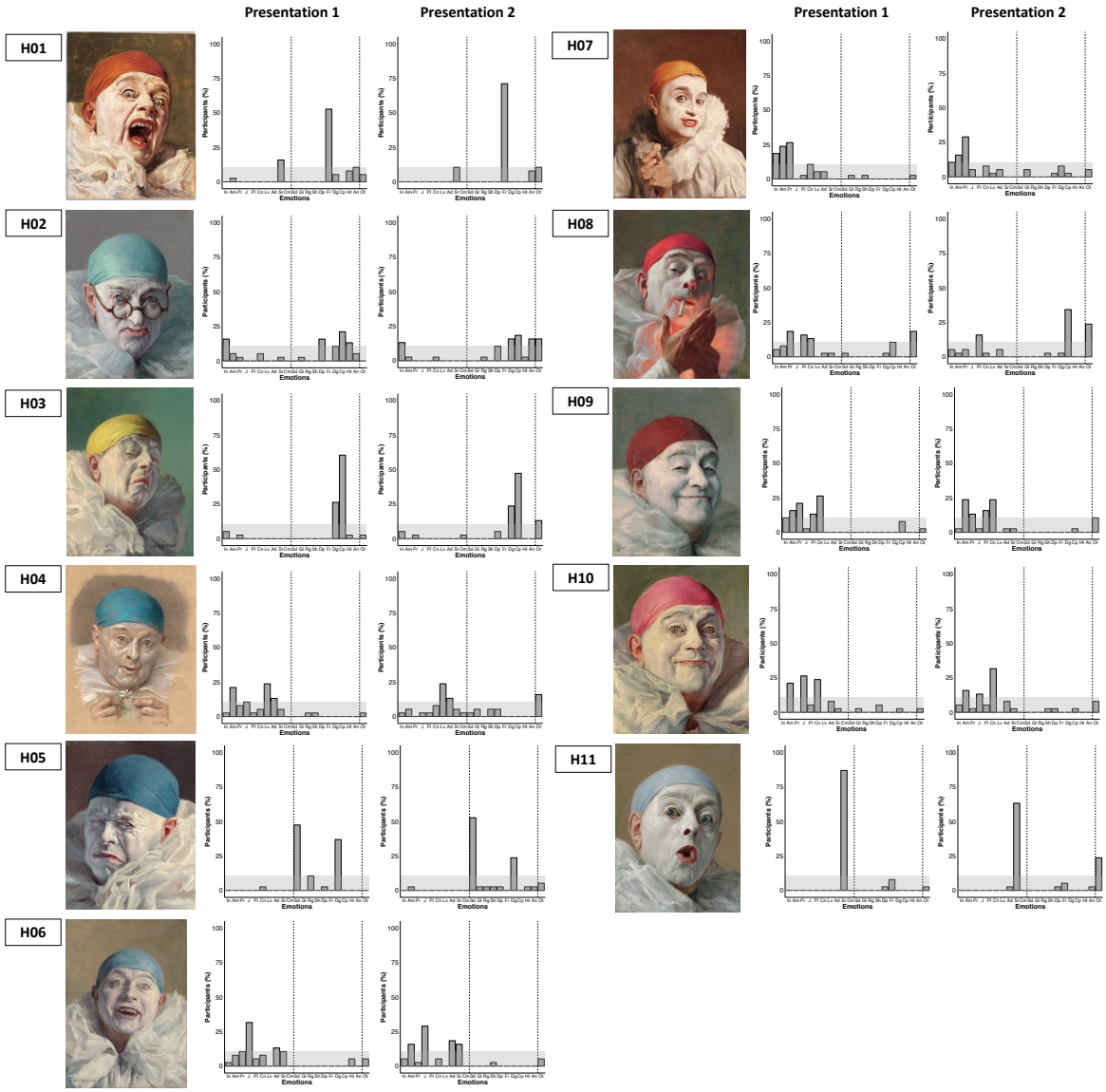

Figure 1. Emotions selected over two presentations for 11 of Armand Henrion's self-portraits.

Armand Henrion's self-portraits used in the current study (permission obtained from the Helmut Klewan's collection, Belvedere, Vienna, Austria; https://osf.io/mf9t5/). The y-axis represents the percentage of participants choosing each emotion, calculated from the total number of participants in that sample. The x-axis represents the 20 emotions as they appear on the GEW in clockwise order, starting from *Interest* (see Figure 2). We added one last category labelled *other emotion*. The central dotted vertical lines separate positive (left) from negative (right) emotions. The rightward dotted vertical lines separate the GEW emotions from the additional *other emotion* category. The grey shaded

areas mark 95% confidence intervals (*95% CI)* around chance levels. We defined that emotion choices falling outside this grey area to be significantly more frequent than expected by chance ($p \leq .050$). Emotions are coded as such (from left to right): In = Interest, Am = Amusement, Pr = Pride, J = Joy, Pl = Pleasure, Cn = Contentment, Lv = Love, Ad = Admiration, Sr = Surprise, Cm = Compassion, Sd = Sadness, Gl = Guilt, Rg = Regret, Sh = Shame, Dp = Disappointment, Fr = Fear, Dg = Disgust, Cp = Contempt, Ht = Hate, An = Anger, and Ot = Other emotion.

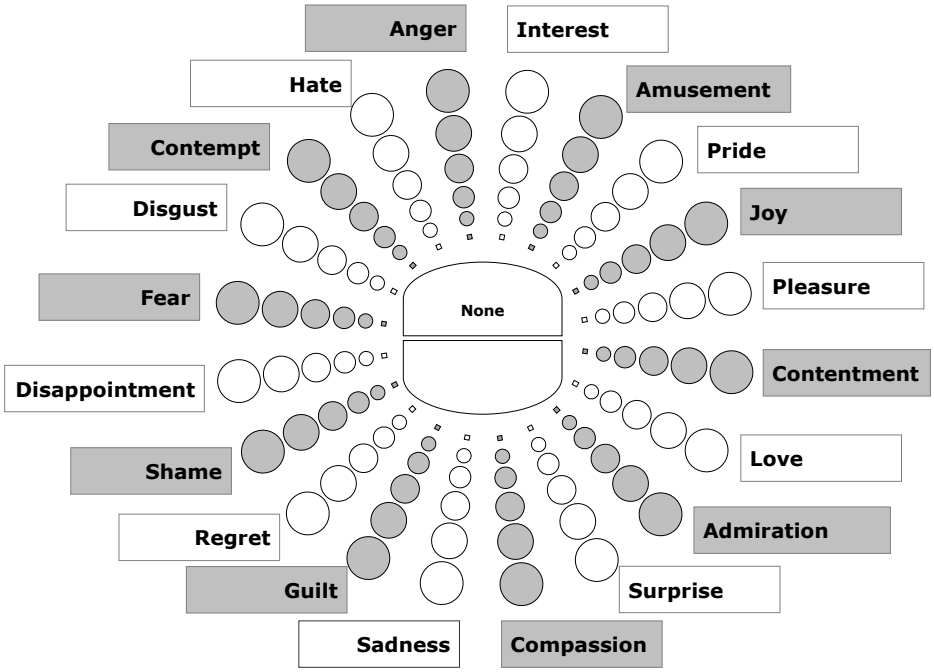

Figure 2. The Geneva Emotion Wheel (GEW) used to assess emotions perceived in Armand Henrion's self-portraits (modified from Scherer, 2005; Scherer et al., 2013 by replacing *relief* with *surprise*)**.**

2.4. Procedure

Participants were tested individually in the laboratory. Upon arrival, each participant received comprehensive study information, signed an informed consent form, and then performed the Ishihara colour vision test (Ishihara, 1993; Figure 3A). Then, the experimenter described the main task in detail. Once participants confirmed that they understood the task, they proceeded to the actual experiment.

We first assessed basic emotion recognition abilities, using the six Ekman's faces. We presented these faces sequentially in one of two orders, either from E01 to E06 or from E06 to E01 (see Figure 3B and Figure 4 for codes). Participants viewed each Ekman's face for approximately 1-2 seconds. Timing was done manually. After each presentation, participants used the GEW to select the emotion on each Ekman's face as well as the intensity of the selected emotion. The experimenter noted down the responses.

In the next phase, we presented Armand Henrion's self-portraits, twice, in the same sequence for a given participant, either from H01 to H11 or from H11 to H01 (see Figure 1 codes). After the first presentation, we assessed participants' spontaneous emotion impressions with the GEW. The procedure was comparable to the one for the Ekman's faces (Figure 3C). That is, the experimenter presented each self-portrait for 1-2 seconds. Directly afterwards, using the GEW, participants selected the predominant emotion on Armand Henrion's self-portrait and selected the emotion intensity. In the second presentation round, participants viewed each self-portrait for as long as they wished (Figure 3D). They were again asked to use the GEW to select the predominant emotion on each self-portrait as well as the emotion intensity (Figure 3D.1.). After each emotion selection, they were asked to describe a situation in which the character might have been (Figure 3D.2.).

Once participants had completed all trials, they were thanked and debriefed. The experiment took between 20 and 70 min (M = 40 min, SD = 9.5 min). This large range in durations originated from the qualitative part of the experiment, which was self-paced (Figure 3D).

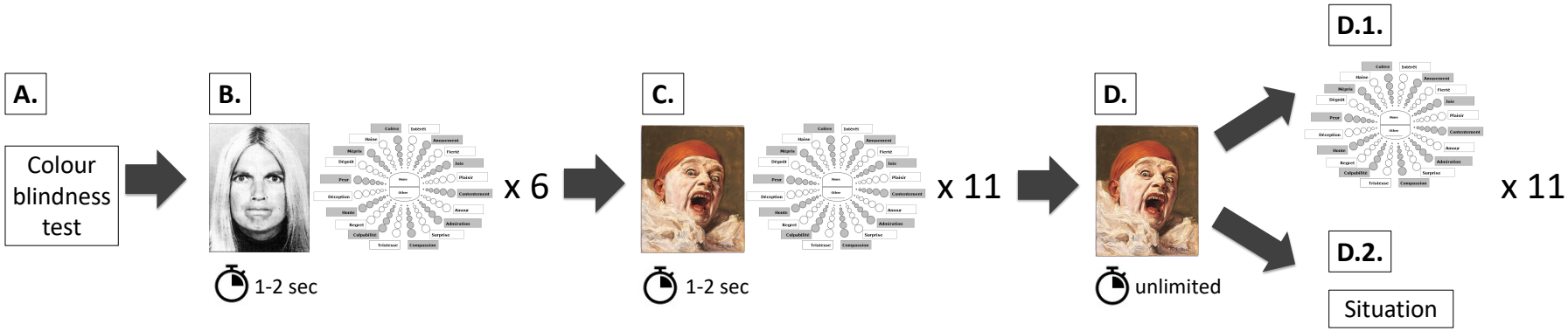

Figure 3. Procedure of the experiment.

(A) Participants completed the Ishihara colour blindness test. (B) Participants identified emotions in each of the six Ekman's faces using the GEW. Each face was presented for 1-2 seconds per image. (C) Participants identified emotions in each of the 11 Armand Henrion's self-portraits using the GEW. Each self-portrait was presented for 1-2 seconds per image. (D) Participants saw the same self-portraits again, but for an unlimited amount of time. They first identified an emotion perceived in each self-portrait (D.1.) and then imagined a situation in which the character of the self-portrait might have been (D.2.).

2.5. Data Analyses

2.5.1. Quantitative analysis

We first analysed the chosen emotions and their intensities for each Ekman's face and each Henrion's self-portrait. To assess whether emotion choices were over- or under-represented, we determined the chance level for choosing each of the 20 GEW emotions plus the separate category of "other emotion". The chance level was 1/21 = 0.048. Then, we calculated the 95% confidence intervals (95% CI) around chance level from the binomial cumulative distribution function for each Ekman's face and Henrion's self-portrait. Put differently, we expected 4.8% of participants (±95% CI) to choose each GEW emotion if emotions were chosen by chance. If emotions were not chosen by chance, frequencies of over-represented emotions would fall above the 95% CI (i.e., more participants would choose them) while frequencies of under-represented emotions would fall below the 95% CI (i.e., fewer participants would choose them). These emotion choices would be significant at $\alpha = .050$.

To investigate whether emotions and their intensities differed between the first and the second presentations, we calculated chi-square tests of independence on presentation (first, second) and emotion for each Henrion's self-portrait. We adjusted the *p*-values for multiple comparisons with False Discovery Rate (FDR) correction (Benjamini and Hochberg, 1995). Degrees of freedom varied between the tests depending on how many emotions had been chosen for each self-portrait. To evaluate intensities, we calculated a 2 x 11 repeated measures ANOVA on intensities with presentation (first, second) and self-portrait (n = 11) as within-subject measures. Intensities ranged from 1 to 5. All statistical analyses were completed, and graphs created using R (v.3.4.0) and R Studio (R Core Team, 2020).

2.5.2. Qualitative analysis

Most participants used between one and five sentences to describe situations in which the character might have been. These were transcribed by the experimenter. To assess major themes in these

descriptions, we applied a coding procedure that was partly based on "open coding" in grounded theory (Glaser and Strauss, 1967) and partly on "clustering" or "theme identification" used by more eclectic approaches (Miles and Huberman, 1994). This approach has been shown to be useful in previous work (Jonauskaite et al., 2020c). In this approach, one coder (CC) identified major themes and coded 11 descriptions of 20 participants. Afterwards, the authors of the article discussed the identified themes and how well they matched the coded descriptions with the goal of improving the themes. At this stage, we eliminated themes that were too general and unspecific (e.g., "the character [of the self-portrait] is satisfied"). In other cases, we realized that themes did not describe situations but emotions the self-portrait displayed. For instance, some participants responded, "he is scared", or "he is surprised". We did not code these themes as "fear" or "surprise". Instead, we phrased these themes as "the character is in a fearful situation" or "the character has experienced something surprising". Finally, other themes were mentioned rarely and thus excluded (e.g., "the character is playing"). After this step, the same initial coder (CC) recoded the same 20 participants using the refined themes. After this step, we reached a saturation point where we could not add or eliminate further themes. A pair of trained coders (CC and YS) then coded the entire dataset on these themes. Their inter-rater reliability was excellent, with a kappa value of $\kappa = .805$ (Cohen, 1960). Disagreements were resolved through discussion.

3. Results

3.1. Quantitative Analysis

The frequencies (in percentages) of emotion choices for Ekman's faces are shown in Figure 4, and for Henrion's self-portraits in Figure 1. We observed a high consensus in emotion choices for Ekman's faces. The majority of participants chose the expected emotions for five out of six Ekman's faces. They predominantly chose *sadness* for E01, *joy* for E02, *disgust* for E03, *fear* for E05, and *surprise* for E06. However, *anger* was not majorly endorsed for its corresponding Ekman's face (E04). While anger was

the most frequent choice for this face, other emotions (*surprise*, *contempt*) were also chosen above chance. (see Figure 4).

We observed more diversity in emotion choices for Henrion's self-portraits. For some self-portraits, most participants agreed on the emotion, such as *fear* for H01 and *surprise* for H11. For other self-portraits, we observed that two emotion choices predominated, such as *disgust* and *contempt* for H03, and *disgust* and *sadness* for H05. For still other self-portraits, more than two emotions were chosen with no clear preference for any particular emotion (i.e., H02, H04, H06, H07, H08, H09, and H10). Importantly, we also observed that some self-portraits resulted in emotion choices that were ambiguous in valence (namely H02, H08, and to a lesser extent, H10): some participants identified positive while others identified negative emotions in these self-portraits (see Figure 1).

When we compared the frequencies with which emotions were matched to Henrion's self-portraits at the two presentation times, the comparisons were not significant ($\chi^2 \leq 2.71$, $p_{FDR} \geq .702$, df = [5-15]). Therefore, participants matched similar emotions per self-portrait at the first and second presentation. The ANOVA on intensities met data assumptions and showed a main effect of presentation, $F(1, 37) = 4.10$, $p = .050$, partial $\eta^2 = .100$. Emotion intensities were higher at the second ($M = 3.66$, $SD = 1.08$) than the first ($M = 3.50$, $SD = 1.09$) presentation. There was also a main effect of self-portrait, $F(10, 236.7) = 23.82$, $p < .001$, partial $\eta^2 = .392$ (Greenhouse-Geisser correction), but no interaction between presentation and self-portrait, $F(7.3, 270) = .70$, $p = .683$, partial $\eta^2 = .018$ (Greenhouse-Geisser correction). The second main effect shows that intensities varied between self-portraits (see Table 1). For instance, the self-portrait H01 displayed the most intense emotions while the self-portraits H02, H04, H07, and H10 displayed the least intense emotions (see Table 1 for detailed results).

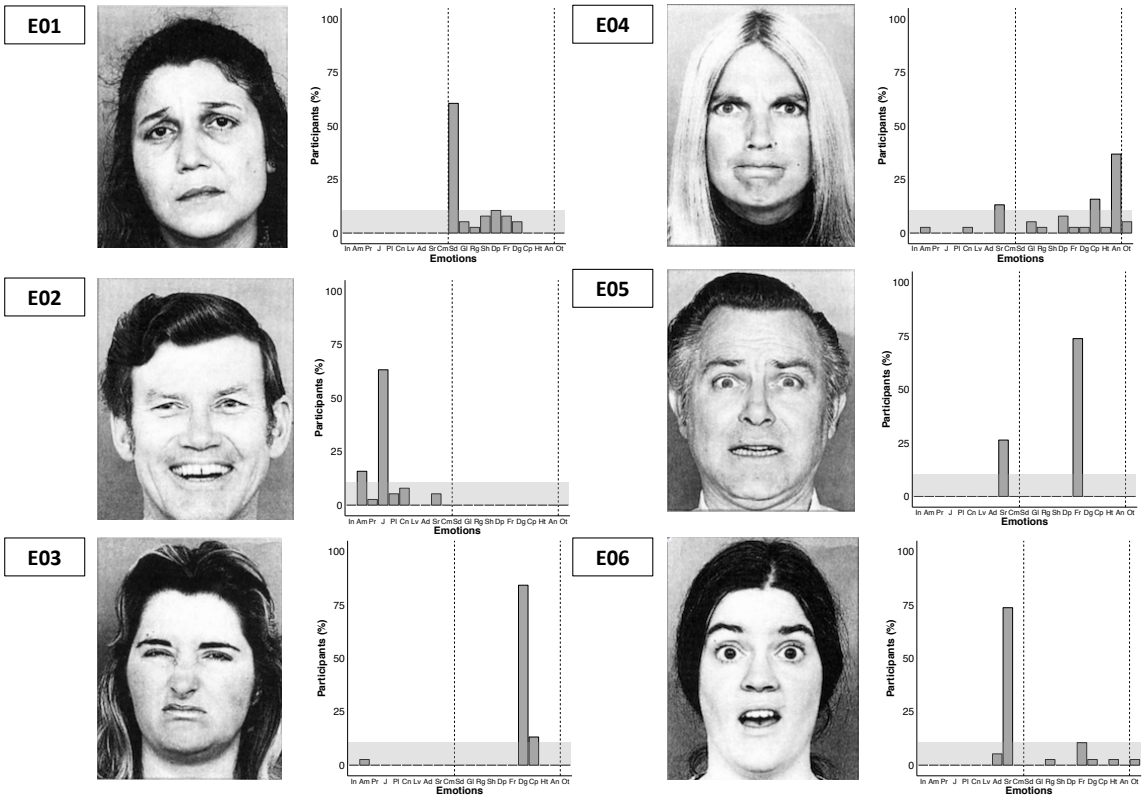

Figure 4. Frequencies of emotions matched to the Ekman's faces, displaying sadness (E01), joy (E02), disgust (E03), anger (E04), fear (E05), surprise (E06).

Table 1. Intensity ratings of each Armand Henrion's self-portrait and their pairwise comparisons within each presentation (i.e., first and second).

	First presentation			Second presentation		
Self-portrait	*Mean*	*95% CI*	Letter	*Mean*	*95% CI*	Letter
H01	4.55	[4.29, 4.81]	a	4.79	[4.63, 4.95]	a
H02	3.26	[2.95, 3.58]	b, c	3.21	[2.88, 3.55]	b, c
H03	3.95	[3.62, 4.27]	d, e	4.11	[3.80, 4.41]	d, e
H04	3.24	[2.88, 3.59]	b	3.34	[2.98, 3.70]	b, c, f
H05	4.16	[3.84, 4.48]	a, d	4.24	[3.99, 4.48]	d
H06	3.66	[3.37, 3.95]	c, e, f	4.13	[3.88, 4.39]	d, e
H07	2.95	[2.60, 3.30]	b	3.05	[2.74, 3.37]	b
H08	3.24	[2.87, 3.60]	b, f, g	3.50	[3.16, 3.84]	c, g
H09	3.84	[3.52, 4.16]	d, e	3.84	[3.48, 4.20]	e, f, g
H10	2.95	[2.63, 3.26]	b	3.24	[2.88, 3.59]	b, c
H11	3.76	[3.37, 4.16]	d, e, g	3.89	[3.57, 4.22]	d, e, g

Note. Columns *Mean* display the mean intensity rating of the self-portrait. Columns *95%CI* display 95% confidence intervals of these means. Column *Letter* displays pairwise comparisons (repeated *t*-tests) of the intensity ratings between each pair of self-portraits, FDR corrected for multiple comparisons (per column). If the same letter is shown for at least two self-portraits in the same column, the letter indicates that the pairwise comparison between these self-portraits was not significant ($p_{FDR} > .050$) and both self-portraits showed facial expressions of comparable intensity (see Piepho, 2004). If two self-portraits have no letters in common in the same column, the pairwise comparison was significant

(p_{FDR} < .050) and the two self-portraits showed facial expressions of different intensities. To interpret the direction of intensity difference, please refer to the columns *Mean*.

3.1.1. Qualitative Analysis of Henrion's self-portraits

Participants thought of diverse situations for each Henrion's self-portrait (see Table 2 in the appendix). We categorised these situations in three to five different themes accounting for around 60-80% of participants' responses, depending on the self-portrait. Situations produced for H11 were the easiest to categorise as we were able to account for 90% of the responses with just three themes. In contrast, situations produced for H07 were the most difficult to categorise as our themes accounted for merely 55% of responses. Participants' situation descriptions complemented their emotion choices. For instance, most participants chose *fear* for H01 and thought the character was in mortal danger, encountered a disgusting animal, got in an accident, or were facing their greatest fear. Most participants chose *surprise* for H11 and thought the character saw something surprising, heard shocking news, or was startled.

When participants had chosen two predominant emotions, their stories were in line with these choices. For H05, some participants had chosen *sadness* and thought that the character perhaps heard some bad news or lost someone close. Others had chosen *disgust* for H05 and thought he was eating or drinking something he did not like. Self-portraits for which participants had chosen diverse emotions sometimes resulted in diverse situations, but not always. For H02, for instance, participants had chosen diverse positive and negative emotions. Yet, most participants imagined that the character was an authority figure, such as a parent, a teacher, or a doctor, feeling superior and judgmental. In contrast, for H08, participants had chosen diverse positive and negative emotions, and situations were also quite diverse. Participants imagined the character feeling superior and judging others, or just taking a break and listening to others (see other situations in Table 2 in the appendix).

4. Discussion

Emotion recognition, in particular from facial stimuli, has been widely studied in psychology (Ekman and Oster, 1979; Jack and Schyns, 2015; Russell et al., 2003). Most studies focus on individual, discrete

emotions, often within the theoretical framework of basic emotions (Ekman et al., 1969; Elfenbein and Ambady, 2002). Yet, emotion expressions are rarely static and discrete. In realistic situations, emotions are highly variable and are often conveyed as mixed or ambiguous expressions. Generating stimuli of mixed or ambiguous expressions for empirical work remains a challenge. Previous research has approached this challenge by capturing expressions from actors (Bänziger et al., 2012), by extracting expressions from film clips (Cowen & Keltner, 2019), or by creating split chimeric faces (Watling and Bourne, 2007). We tested the potential utility of Armand Henrion's self-portraits for empirical emotion work, given that these portraits express highly mixed and ambiguous emotions. In each self-portrait, the artist depicts himself as a Pierrot clown. We asked participants twice to identify the predominant emotion they saw in each self-portrait as well as the emotion intensity. The first time, they saw each self-portrait for about 1-2 seconds, while the second time, they had no time constraints. During the second presentation, participants also described a situation in which the character in the self-portrait might have been. This latter part provided rich qualitative data.

Participants matched Armand Henrion's self-portraits to a variety of the 20 provided emotions. Participants agreed on a single predominant emotion for only two out of the 11 self-portraits. For two other self-portraits, two emotion choices predominated. For the remaining seven self-portraits, participants identified an array of diverse emotions, including some that varied in terms of valence, being positive for some and negative for others. We also found that participants' emotion choices did not differ between the first and second presentation, but they rated emotions as more intense the second time. This increase might be due to longer presentation times or because participants saw the self-portraits for the second time. In both cases, longer cognitive processing might have allowed participants to fully appreciate the self-portraits and grasp their emotional meaning. Previous studies on aesthetic pleasure reported that participants looked longer at stimuli which they liked more, irrespective of whether they were looking at faces or paintings (e.g., Goller et al., 2019). However, while aesthetic pleasure responses peak at 2.5 seconds, they seem to be independent of stimulus

presentation time, at least when the latter is between 1 and 30 seconds (Brielmann et al., 2017). Thus, reasons for these particular results remain uncertain.

Participants' qualitative situations complemented emotion choices. In cases where two emotions dominated for a self-portrait, descriptions were in line with these emotion choices. For instance, participants who perceived *sadness* in one of the self-portraits also thought that the character had heard some bad news or had lost someone close. Other participants who perceived *disgust* in this same self-portrait thought that the person might have eaten or drunk something very unpleasant. Overall, qualitative responses highlighted the ambivalent and mixed nature of facial expressions in Armand Henrion's self-portraits. However, we could not categorise all descriptions. Depending on the self-portrait, 20-40% of responses remained uncategorised, further indicating diversity and ambivalence of these self-portraits.

Limitations and Future Directions

Our study was limited in the selections of Armand Henrion's self-portraits, the control stimuli, and the number of emotion labels (i.e., emotion terms). Future studies would benefit from at least three design changes: i) a larger variety of Armand Henrion's self-portraits, ii) inclusion of different control image sets, and iii) a wider range of emotion labels.

We restricted our sample of Armand Henrion's self-portraits to the artworks available at the Helmut Klewan's collection, curated by the Belvedere Museum in Vienna, Austria. Yet, the artist had produced many more of these self-portraits. Very likely, a larger set of self-portraits would have led to a larger diversity of perceived emotions, both within and across images. By doing so, we might have been able to map a wider space of affective dimensions (e.g., valence, arousal, power) or have portraits that were more reminiscent of the basic emotions displayed on Ekman's faces. To expand the control image sets, one could include more contemporary material, consisting not only in faces but also in paintings, drawings, photographs, video clips, or emoticons (see Diconne et al., 2022; Fekete et al., 2022;

Schmidtmann et al., 2020a for potential databases). To expand on emotion labels, studies could go beyond the 20 emotions we studied here and consider many more affective and mental states (Schmidtmann et al., 2020a, 2020b).

Other potential limitations of the current study include: i) randomisation, ii) between-subjects measure of mixed emotions, iii) familiarity with the self-portraits, and iv) colours of the head bonnets. Regarding randomisation, each participant was tested by one experimenter. After some practice runs, we decided that experimenters would alternate between two possible presentation orders for both the Ekman's faces as well as Henrion's self-portraits. While this design choice was taken due to the manual paper-based method conducted by a single experimenter, ideally, stimulus order would have been fully randomised between participants.

Regarding the between-subjects measure, participants matched a single emotion to each self-portrait. Therefore, future studies should test whether mixed emotions can be detected on an individual level too. Regarding familiarity, we failed to explicitly assess participants' familiarity with the artist and his self-portraits. Research has indicated that more familiar faces are perceived as more positive, and are also more liked, than unfamiliar faces (Carr et al., 2017; Claypool et al., 2007). Moreover, familiar artworks are often preferred to less familiar ones, having similar valence and arousal ratings (Song et al., 2021; van Paasschen et al., 2015). Such results can be explained within the framework of the mere exposure effect, indicating that previously encountered stimuli, hence being more familiar, are preferred to the novel ones (Zajonc, 1968). This effect might be due to a higher salience of familiar stimuli (Mrkva and van Boven, 2020). However, we doubt that mere exposure and familiarity are crucial to our study, because Armand Henrion is not a particularly widely known artist (at least not to the extent as artists like Vincent van Gogh or Pablo Picasso). There is relatively little information on the artist via the internet. At the moment of manuscript submission, we also noted that his works were

on sale in auctions with prices being in the realm of hundreds rather than millions of euros compared to prices for artworks by more famous artists [1].

Regarding the colours of the head bonnets, they might have influenced participants' emotion choices as well. Research on context-free colours indicated stable links between colours and emotions (Jonauskaite et al., 2020a; Valdez and Mehrabian, 1994), and so did research on facial coloration (Thorstenson et al., 2018). Thus, head bonnet colours might have affected participants' decisions on facial expressions or their intensities. For example, a red bonnet might have guided participants to choosing *anger* more easily than a blue bonnet. Similarly, considering that red is often associated with arousing emotions (Valdez and Mehrabian, 1994; Wilms and Oberfeld, 2018), a red bonnet might have encouraged participants to choose more intense or more arousing and powerful emotions.

4.1. Conclusions

Our study shows that Armand Henrion's self-portraits display mixed and ambiguous emotions. Thus, they might be useful stimuli in this line of research. Moreover, these stimuli could be valuable to more applied domains, like counselling or clinical settings, as people found it easy to think and talk about diverse affective situations. Potentially, these situations might be influenced by their own personal experiences or interpretations of the images, and so open avenues for discussions. Finally, these images might be particularly useful in populations where visual stimuli are preferred, such as children, elderly, or people with low literacy levels.

[1] https://www.invaluable.com/artist/henrion-armand-bzww9rzuvr/sold-at-auction-prices/

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Appendix

Table 2. Situations (themes) extracted for each Henrion's self-portrait from participants' open answers.

We report situations and frequencies of participants describing each situation from the total number of participants for each self-portrait. We also provide some quotes to exemplify the situations. Frequencies are not exclusive, meaning the same quote might apply to several situations. Situations we could not further categorise are grouped under the "None of the above" category, which is exclusive. We inserted text in squared brackets for clarity.

Armand Henrion's self-portrait	Situation (%)	Quotes
H01	The person is in mortal danger caused by someone or something (23.7%)	*"When someone aims to kill us or aims to hurt us (more physically than psychologically)." (P_03)* *"Someone wanted to kill him." (P_07)* *"It is as if something is invading him. A bravliva bird (a Bulgarian eagle-like bird) with sudden movements. A bird which wants to attack him." (P_09)*
	The person is looking at a disgusting animal or insect (spider, rat) (21.0%)	*"When I see my female friends looking at insects or other scary things […]." (P_113)* *"Laura sees a rat in the cellar." (P_08)*

The person is involved in or witnessing an accident (15.8%)	*"He saw something really terrifying, such as an accident." (P_05)* *"When you are driving and when a car from the opposite lane comes towards you, a tragic situation" (P_16)*
The person is facing his greatest fear (13.2%)	*"Someone who is horrified, who has just seen his greatest fear (a spider, for example) and wants to jump on a piece of furniture. He is looking at the worst thing in the world." (P_108)* *"He has arachnophobia and I am showing him a spider. He is screaming, laughing or he is scared" (P_04)*
The person is watching a (horror) film (7.9%)	"*It reminds me of horror movies. Something horrible that you discover: a monster, a corpse. But not in reality or not as strong. Something surprising or terrifying." (P_100)* *"A typical situation, also of disgust. A scene that impresses you in a negative way. In front of a film that disgusts you and scares you (…). " (P_17)*
None of the above (36.8%)	

H02	The person feels superior, judges or despises the person in front of him (31.6%)	*"I see him speaking contemptuously to a child, not taking him seriously, making derogatory remarks, making fun of* [him]*." (P_103)* *"With these glasses, he is listening to someone who said something stupid and out of context (intellectually). He is disgusted by the other person's lack of knowledge." (P_12)*
	Impersonation of a teacher who judges their students (15.8%)	*"A teacher looking at his class with anger or disappointment. He is angry because they got a bad grade, and he is holding back from saying something nasty." (P_108)* *"Imitation of an old college professor who speaks in a strange manner or an actor imitating a politician" (P_16)*
	Impersonation of an authority figure such as parent, grand-parent, elderly person (15.8%)	*"An old village woman who wants to yell because we have made too much noise, too loud, and for too long." (P_116)* *"A grandfather is angry with his grandchildren. They are again in his garden" (P_111)*

	The person has witnessed someone else making a mischief (7.9%)	*"A grandfather who has just seen his grandchildren doing something they shouldn't. But something minor, such as a child breaking a glass." (P_102)*
	Impersonation of a healthcare professional such as doctor, surgeon, dentist, etc. (7.9%)	*"A dentist who is going to pull out a wrong tooth." (P_08)* *"He looks like a doctor, a surgeon. He doesn't know what to think, he's quite judgmental." (P_11)*
	None of the above (39.5%)	
H03	The person feels superior, judges the person in front of him (42.1%)	*"A bourgeois looking at a beggar. Someone who is verbally but not physically aggressive." (P_103)* *"A person from a higher social class passing by a group of people from a lower social class. He is disgusted by this view." (P_114)*
	The person feels or sees something bad or dirty, or something he does not like (23.7%)	*"He is disgusted because he sees someone throwing up." (P_04)* *"There is something on the table he doesn't want to eat it." (P_05)*

		"This is disgusting, and it stinks. When you are walking on the street and you smell sewers, or a passing-by garbage truck and you suddenly regret having inhaled [the air]*." (P_01)*
	The person is in front of others he does not like (15.8%)	*"He is looking at someone he really does not like. He only feels hatred and disgust for that person." (P_110)* *"Maybe when you see racism. Racism in Namibia, a German colony. When you cannot tolerate it" (P_16)*
	None of the above (26.3%)	
H04	The person is holding a flower (without the game he (she) loves me…) (31.6%)	*"A person in love with another. He is removing the petals from the flower, trying to make a move." (P_06)* *"The situation is already in the picture. He is stripping his flower with a blissful look on his face. He does not think about anything." (P_107)* *"He seems to be amused playing with his little flower. He is having fun, he is satisfied, he is happy." (P_106)*

The person looks like a child (23.7%)	*"He looks like a child. When a child finds something new and wants to show it." (P_115)* *"He reminds me of Gollum* [Lord of the Rings character]. *The flower is the ring. He is trying to look cute but in fact he is not at all. A kid who has done something stupid and who is trying to make it disappear. " (P_18)* *"The Dinner Game/Le Dîner de Cons. He does not hide his emotions. He is full of emotions, full of regret. Childish emotions." (P_109)*
The person declares his love or he is in love (21.1%)	*"Here, I feel someone who has an interest and wants to make a confession of love." (P_01)* *"He is telling me how beautiful the girl he loves is." (P_04)* *"Sternberg's book "Of Mice and Men": a kind lover, violently dangerous. A guy deeply in love, without control, by loving too much, he kills. With the flower, he is nervous and he is tearing off all the petals" (P_08)*

	The flower petal game "He (she) loves me, he (she) loves me not" (10.5%)	*"A gentle movement of picking up a flower to give it* [to someone else]. *The game "He (she) loves me, he (she) loves me not", with the daisy." (P_17)* *"[…] The flower game "He (she) loves me, he (she) loves me not", when you are a child." (P_101)*
	None of the above (36.8%)	
H05	The person is eating or drinking something he does not like (23.7%)	*"This one is for people who do not like lemons very much, this is disgust." (P_01)* *"When your stomach hurts or you have eaten something you don't like." (P_117)* *"As if he has just eaten something very bitter. For instance, a green almond with a crunchy skin." (P_09)* *"When you have just eaten something you hate, like coriander" (P_14)*
	The person has heard some bad news (15.8%)	*"He is angry because he has heard bad news." (P_07)* *"Bad news (death, anything). Emotional sadness, loss of something, no pain." (P_102)*

The person is crying (15.8%)	*"He is feeling very bad, crying" (P_05)* *"It looks like he is holding his tears but they will still flow. He is helpless facing a scene he cannot intervene" (P_108)*
The person has lost something or someone (15.8%)	*"Something that makes you sad. His dog has died." (P_13)* *"He has emotional sadness, like pain. When someone of you family died, a close one. Or when you ask yourself existential questions for which you have no answers. Therefore, it is destabilizing" (P_11)* *"Here, trying not to cry while thinking about someone who is no longer there but whom he loved. It makes him unhappy, sad." (P_12)*
Impersonation of a child (15.8%)	*"I can easily imagine a capricious child, because his mom would not give in to his whims." (P_03)* *"A child in a supermarket. We did not buy him what he wanted. He is going to sulk rather than cry." (P_114).*

		"A child who has just been told that he will not receive a gift. Teary eyes, we can feel that he is going to cry." (P_15)
	None of the above (29.0%)	
H06	Reaction to a joke or an amusing story (18.4%)	*"He has heard a joke and he is laughing. He is laughing but, at the same time, he is surprised." (P_110)* *"Someone who tells you a funny story and you are laughing at the end". (P_117)*
	The person has heard some good news (13.2%)	*"He has received good news like he might have heard he has been accepted to a good university (…)." (P_12)* *"Someone who has just gotten good news. Someone who is going to be a dad. Joy hard to imagine. He is happy but he is going over it in his head* [i.e., thinking repeatedly about it]*". (P_102)*
	The person is seeing something for the first time (13.2%)	*"Me, I made that expression when I saw a concert for the first time. Seeing an actor or a singer. A situation you can't imagine living yourself". (P_16)*

		"A small child who is going to the cinema or the circus for the first time. Everything surprises him." (P_114)
	The person has seen someone he had not seen for a long time (13.2%)	*"When you open the door and a person you haven't seen for a long time is there. It is like a surprise visit which makes you happy." (P_03)* *"He is seeing a person he has not seen for a while. Extremely happy to see someone he hasn't seen." (P_15)*
	Impersonation of a child (13.2%)	*"It reminds me a lot of children when you bring them a present they have been hoping for." (P_101)* *"A happy child. Something amazes him. He is seeing something he has never seen before. He is blown away by what he sees." (P_111)*
	None of the above (34.2%)	
H07	The person is showing something (a coin) (31.6%)	*"A kid showing something to his classmates. He envies others" (P_01)* *"A friend who comes to show you a picture, happy and a little sarcastic". (P_15)*

	The person is performing a prank, a joke, or a magic trick (10.5%)	*"It looks like he is talking to someone to trick them with the coin in his fingers". (P_06)* *"It is amusement. When you are telling a joke and you are already laughing because you know how it ends while the others are waiting to hear the ending (…)" (P_11)*
	The person is eating something (7.9%)	*"Happy because he is eating a biscuit." (P_07)* *"He is tasting something he doesn't like, but he is still surprised by the taste". (P_106)*
	None of the above (44.7%)	
H08	The person feels superior, judges or despises the person in front of him (36.8%)	*"The person shows contempt for what has been said to him or for the person in front of him. More negative than positive" (P_100).* *"He is watching with amusement someone who is telling something naïve." (P_105)*
	The person is smoking or lighting up his cigarette (31.6%)	*"He is lighting his cigarette. When I go out with friends who are lighting their cigarettes. He seems a little mocking, a little fake." (P_15)* *"He is like a spectator, equal to equal. He is not there to judge. He is smoking his*

		cigarette, he is taking in, no violation." (P_113)
	The person is taking a break to rest during or at the end of the working day (18.4%)	*"He seems happy to light up his cigarette. Someone who is taking a short break, he lights up a cigarette and takes time for himself, and he is happy about". (P_106)* *"A task is finished. Everything stops while he is smoking this cigarette. He is relieved." (P_114)*
	The person is listening to a conversation or to another person (18.4%)	*"Curiosity. Kind of like, I am listening carefully to what you are telling me, because it could be useful for me (…)." (P_10)* *"As if he is listening to someone and he finds everything this person is telling him to be absurd. He doesn't respect him. He considers himself to be better, the best, above that person." (P_103)*
	None of the above (23.7%)	
H09	The person is satisfied for another reason (42.1%)	*"When you are listening to a good piece of music while sitting in your comfortable chair". (P_01)*

		"An expression that is a little bit mocking but not necessarily in a negative way. For instance, "Ah you see, I was right"." (P_17)
	The person is satisfied because he was successful in a task or has passed an exam (13.2%)	*"I have passed my exam better than you." (P_02)* *"Very happy, very proud of what you've done. After an exam that you have passed very well, you are satisfied." (P_117)*
	The person is satisfied because he has misbehaved (10.5%)	*"Someone who did something bad, nasty, he is a little bit mean but also proud of himself." (P_14)* *"He is about to do a mischief. He is impatiently waiting for things to happen." (P_15)*
	The person is satisfied because he is eating or drinking something he likes (7.9%)	*"He drank the best beer in the world". (P_04)* *"When you are eating a good chocolate cake." (P_16)*
	None of the above (26.3%)	

H10	The person is in a satisfactory situation (36.8%)	*"In the kitchen, when you've made a cake and the visual result is like you wanted." (P_01)*
		"Happy, enjoying his life. He looks like he has been asked to smile, for instance, for a class photo" (P_15)
		"Someone who has told a joke and who is happy about the effect it had. A controversial joke." (P_104)
		"In a crowd of people, you see someone you really like". (P_109)
	The person has mixed feelings (21.1%)	*"He is looking at someone and he doesn't know if what the person is doing is a good thing or not. He is happy but at the same time he is a little scared". (P_06)*
		"Someone who thinks differently from him. He is disappointed that this person thinks that." (P_108)
	The person was successful in a task or has passed an exam (13.2%)	*"When you manage to pass an exam or receive a gift you've been waiting for". (P_16)*
		"He has accomplished a task, which was not necessarily difficult but it was done well and he wants to show it to others." (P_114)

	The person is trying not to laugh (7.9%)	*"When you see a situation that amuses you and you have to hold back from laughing because this is not the right moment." (P_101)* *"In class, you are not allowed to laugh, but your friends are making you laugh by saying something funny". (P_117)*
	None of the above (29.0%)	
H11	The person sees someone or something surprising, positive or negative (65.8%)	*"At the circus, when a clown is watching acrobats perform acrobatics. He is amazed". (P_01)* *"I am showing him something precious, like a diamond." (P_04)* *"Amazed by his dish, by what he was served." (P_07)* *"Astonished, he is surprised. A parent who finds his kid in a place where he shouldn't be, such as an electrical room." (P_08)*
	The person has heard some news (23.7%)	*"She is pregnant." (P_09)* *"When you tell him about someone's death but he already knows it. Surprised." (P_10)*

	"He learns about something that has happened that he didn't know about, something unexpected." (p_116)
The person is startled because of something that has fallen (and broken) (10.5%)	*"Something falls and we are surprised." (P_03)* *"I have broken a glass. I turn to my brother: "Look what I have done!"." (P_114)*
None of the above (10.5%)	