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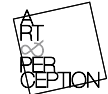
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# Exploring Facial Expressions in Pietà and Nativity Paintings Throughout Time

Erin Mino<sup>1,\*</sup> and Maarten W. A. Wijntjes<sup>2</sup>

<sup>1</sup>Faculty of Social Sciences, Utrecht University, Utrecht, the Netherlands

<sup>2</sup>Delft University of Technology, Delft, Landbergstraat 15, 2628 CE Delft, the Netherlands

\*Corresponding author: erinminocx@gmail.com

ORCID: Mino: 0009-0004-7739-3073; Wijntjes: 0000-0002-3657-735X

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## Abstract

This study explores the development of depicting facial expressions in historical paintings representing pivotal religious scenes: the Nativity (Birth of Christ) and the Pietà (Death of Christ). By examining artworks spanning the 11th to the 19th century, we assess how depictions evolve over time in terms of polarity, agreeability, and ambiguity of individual faces, and compared these with the perceived emotional intensity of the overall pictorial scene. A total of 56 paintings were randomly selected to be evaluated by 150 participants. Each participant categorised all visible faces into one of ten emotion categories – ranging from joy and love to sadness and anger – and then rated the painting's overall emotional intensity. We quantified the degree of viewer agreement (agreeability), calculated a polarity measure (positive versus negative emotion balance) and ambiguity (amount of chosen categories) at the face level. We also measured how participants perceived each painting's emotional intensity. Results showed that Pietà paintings were generally rated as both more emotionally intense and more uniform in their expressions than Nativity artworks. Moreover, Nativity paintings exhibited a gradual rise in their polarity over time, whereas Pietà scenes did not display a clear temporal trend. Furthermore, we found a clear relation between creation year and ambiguity in facial expression, but not with agreeability. The emotional intensity of the overall paintings also increased with the creation year. Together, these findings suggest empirical evidence for a historical change in the depiction of facial expression.

## Keywords

facial expression, Pietà, Nativity, distant viewing, emotion depiction

## 1. Introduction

Recognising emotions through facial expressions is an important aspect of human interaction, shaping our social connections and communication. The ability to decode emotions is not only crucial in everyday life but could also influence how we perceive and interpret art. The narrative structure of figurative artworks relies on the accurate depiction of characters' intent, which is mediated by facial expression. Historical artworks, with their rich tapestry of expressions, offer a unique window into the emotional landscapes of past eras (Bollmer, 2019). Although many see the expression of emotion in the real world as universal, research finds mixed results (Barrett, 2006; Gendron *et al.*, 2014; Jack *et al.*, 2012). Depiction of facial expression may also not be fully universal and could have changed over time. Artistic style and time are conflated in the corpus of historical paintings (Zhao *et al.*, 2023), so these changes may be difficult to attribute to either changes in the interpretation of expression, or changes in artistic style. Nevertheless, it seems worthwhile to initiate a first step towards an empirical understanding of the depiction of facial expression.

## 2. Perceptions of Facial Expressions

Being able to read others' expression enables individuals to interpret their feelings and intentions. This is crucial in facilitating trust, empathy, effective interactions, and more (Buck *et al.*, 1972; Frith, 2009). The common view is that subtle cues from the combination of movement of facial muscles signal certain emotion categories that are commonly recognisable by humans (Barrett, 2017). Studies suggest humans are very accurate in recognising emotions from others, with a large-scale study by Dores *et al.* (2020) finding agreement rates as high as 97%. However, it seems that accuracy is highest in recognising facial expressions of happiness and surprise, less so at expressions of anger, sadness, fear or contempt, with agreement rates dropping as low as 69% or 50% (Dores *et al.*, 2020; Martinez and Du, 2017). Nonetheless, these findings do not seem to be universal, as a cross-cultural study by Keltner and Cordaro (2017) found the opposite effect of negative emotions being generally better recognised, while happiness was correctly identified in around 75% of cases. This variability highlights the complexity of emotional perception and our mixed ability in decoding emotions.

In art, facial expressions of the depicted characters play an important role in communicating the painting's intended affect (Codell, 1986; Robinson, 2007). Additionally, the viewer's ability to recognise and receive emotion from an artwork is an important contributor to its aesthetic value (Dolese *et al.*, 2014).

Despite this, although various studies have investigated the emotionality of paintings, this is rarely done through the lens of the facial expressions depicted in them. Mullennix *et al.* (2021) investigated the effect of priming in the interpretation of facial expressions but chose neutral portrait paintings as their dataset. Enhancing our understanding of the effect of facial expressions in art can bridge the gap between artistic intent and viewer perception, potentially enriching both art history and emotion recognition fields.

### 3. Brief History of Emotion Depiction

The depiction of emotion in art has undergone significant transformations throughout history, reflecting broader cultural, political, and artistic shifts. Early art from Egyptian and early Greek eras showcased gods and figures of impassive expressions, with art serving as representation of the world instead of an aesthetic or emotional experience (Gombrich, 1995). The Hellenistic period marked a shift towards more expressive depictions, with sculptures often portraying dramatic and vivid scenes (Gombrich, 1995). However, later focus shifted back towards portraying religious figures of the church with clarity above all else (Gombrich, 1995). Soon, the gothic artists of the 11th and 12th century became somewhat more interested in telling an emotional story, drawing and sculpting more expressive gestures and facial expressions (Kleiner, 2008). In the early 14th century, the work of Giotto is often labelled as groundbreaking in depicting human emotion, bringing new traditions to medieval art (Souter, 2019).

After Giotto, religious art placed importance not only on symbols, but also depicting their expressiveness with heightened intensity (Gombrich, 1995). By the 16th century, the Renaissance saw artists like Michelangelo and Raphael introduce nuanced expressions and gestures, and by the 17th century, artists like Bernini had achieved unprecedented intensity of emotionality and expression (Gombrich, 1995). From the 17th to the 19th century, many movements emerged as a reaction to one another. While ones like Classicism valued restraint, Baroque art placed great emphasis in its emotional involvement, drawing faces that expressed their emotions clearly (Kleiner, 2008). By the end of the 19th century, artists like Van Gogh had moved away from depicting correct representations and shifted focus to conveying an emotional experience through brushwork and colours. The 20th century marked a significant departure from previous norms, with artists using abstractions and bold techniques to mirror their emotions (Kleiner, 2008). Throughout history, the dynamic interplay between artists, subjects and observers, has driven the evolution of expression and the emotional communication of art.

#### 4. Considerations on Understanding Facial Expression

As there are ongoing debates about the universality of emotion across culture, likewise, there may be significant diversity in how humans have understood and experienced emotion throughout time. Nowadays, artists have a masterful grasp on facial and gestural expression, with animation simplifying expression to almost unmistakable representations. In contrast with older artwork, styles of animation do not focus on realistic depictions but rather show an idea or an exaggeration (Buchanan, 2009). Research confirms that ideographs of emotion, such as emoji, are sometimes even better recognised than human expressions (Dalle Nogare *et al.*, 2023). But the schema used today to refer to emotions is not necessarily the same as in the past. The art observer of the 14th century might have been shocked at Giotto's ability to display clear emotionality, but the depiction may be difficult for a modern viewer to understand.

When people talk of emotion, a multitude of different words are used to express them, referring to a rich variety of emotional states. Darwin's proposal of six basic emotions (joy, sadness, anger, fear, disgust, and surprise) has received considerable support and popularity in emotion studies, also finding that facial expressions of them are reliably identified across cultures (Ekman *et al.*, 1969; Elfenbein and Ambady, 2002). This belief belongs to the discrete emotion theory, which posits that there is a limited set of fundamental emotions all humans can recognise. However, a good deal of emerging literature challenges this, with findings that people can recognise over 20 facial emotions, and one cross-cultural study identifying core patterns (and variations) in expressions of 22 emotions (Cordaro *et al.*, 2018; Keltner *et al.*, 2019). These advances suggest a move towards a more nuanced understanding of human emotional expressions.

While some propose the existence of distinct emotional states, a major theoretical position is represented by the dimensional theory of emotion. This view suggests that emotions arise from a combination of more fundamental dimensions, including arousal (intensity of emotion), valence (pleasantness of emotion), and sometimes dominance (whether the emotion involves feeling empowered versus powerless) (Barrett, 1998; Mehrabian, 1980). A literature review by Mauss and Robinson (2009) favoured the dimensional framework over the discrete, finding that it accounts for most of the variability across physiological and behavioural measures of emotion. However, the two theories are not necessarily conflicting if discrete emotions are understood as emerging from combinations of dimensions – for example, anger as a mix of negative valence, high arousal, and high dominance. A study on facial emotion recognition found that categorical and dimensional processing can co-occur, supporting a hybrid model for decoding facial expressions (Fujimura *et al.*, 2011). Building on this, the present study will have participants categorise

facial expressions into distinct emotions but analyse partially based on their dimensionality.

## 5. Aims of the Current Study

Despite some existing studies on facial expression recognition in drawings (Erdos *et al.*, 2001; Kostić *et al.*, 2020; MacDonald *et al.*, 1996), the topic and its nuances remain underexplored in the field of art. To bridge this gap and gain a richer understanding of the depiction of facial expression in art history, the current study adopts an empirical approach to map facial expression recognition in historical art by modern audiences. Participants will be shown a range of historical paintings and asked to categorise the emotional expressions conveyed in the faces depicted in them. By analysing the level of agreement among participants, we can explore how consistent people's interpretations of facial expressions in art are, investigate how this agreement changes with time, and how it relates to the emotional intensity of the overall painting. Related to the agreement metric, we also investigate ambiguity as quantified by the number of different expression labels for a single stimulus (e.g. if some participants choose 'love', others choose 'happiness', and others choose 'interest', the ambiguity value would be three). Besides focusing on individual faces, we are additionally interested in how an ensemble of faces contribute to the overall impression of the painting. We operationalise this by letting participants rate the overall emotional intensity of the paintings. These rating data may provide insights into whether the individual facial expressions amplify or inhibit the overall emotional impression of the scene.

As there is no 'ground truth' in paintings, we want to choose paintings that have a relatively unambiguous emotional interpretation, and where the depicted facial expressions can be assumed to be congruent with the artists' intention. Moreover, we concentrate on paintings of the same topic that have been repeated throughout history, allowing us to better observe their evolution and to somewhat limit the effects of theme and composition in studying the painting's intensity. Therefore, the stimuli will consist of a collection of two different painting themes: 'Nativity' (depicting the Birth of Christ, emotionally positive) and 'Pietà' (depicting the Death of Christ, emotionally negative). The choice of these two themes offers the additional benefits of religious art being prevalent in older centuries, and the presence of various characters ensuring a wider array of emotions can be observed. Moreover, the contrasts in emotional valence between the two themes can allow us to explore whether differences in valence might also influence the viewer's recognition accuracy or the emotional intensity of the painting.

This study concerns both the perception and the depiction of emotional facial expressions. Quantitative, comparative pictorial research is called

‘distant viewing’ (Arnold and Tilton, 2023) and often concerns computational approaches. Using human vision instead of computer vision to collect the annotation data has the disadvantage of being less scalable, but the advantage of better reflecting human impression through the inherent subjectivity (Wijntjes and van Zuijlen, 2024). Although computationally summarising emotions is mentioned in the context of distant viewing (Arnold and Tilton, 2019), we have only found one distant viewing study related to facial expression: Jofre and Cole (2024) studied facial imagery in *Time Magazine* between 1923 and 2014. The facial expression annotations were limited to smiling and besides gender differences (females smile more, as previously found in year-book portrait analyses, e.g. Dodd *et al.*, 1999) they found a clear increase in smiles between 1923 and 1940. Another study that made use of emotion annotations investigated the relation with aesthetics and focused on the emotion experienced by the viewer rather than expressed by the depicted persons (Stamkou *et al.*, 2024). Thus, despite seemingly sufficient motivation to study the depiction of facial expression within a distant viewing framework, there are relatively few existing studies. Therefore, one of the aims of the current study is to acquire experience that may serve future studies on the depiction of expression.

In terms of the emotional categories used in the study, we aim to be consistent with previous research while aligning with the chosen themes. Despite acknowledging the extensive range of identifiable emotions, this study will focus on a subset of them in favour of methodological clarity and feasibility. To facilitate comparisons with previous studies, we will use the common six basic emotions, along with four additional categories, totalling ten. One of the additional emotions will be contempt, as it is somewhat commonly used in recognition studies involving photographs (Dores *et al.*, 2020). The other two will be interest and love, included due to fitting the portrayals of the Nativity scene well, and research which indicates they are important emotions identifiable through facial expressions (Cordaro *et al.*, 2018; Shiota *et al.*, 2011). The selection also follows the emotions present in the Geneva Wheel of Emotions framework and ensures a balanced representation of positive and negative emotions given our two themes (Scherer *et al.*, 2013). The last category will be neutral to anticipate on faces that do not express any (or incomprehensible) emotion.

This study is exploratory in nature, seeking to gain broad insights into facial expressions in paintings. This includes questions about the difference in depiction between positive and negative emotions, which emotional categories dominate or cluster across themes and periods, or how gender influences emotional portrayal. Nonetheless, there is particular focus on two major hypotheses. First, we expect a decreased ability to accurately recognise and agree upon the facial expressions in older paintings. This may come partially

as a function of the increasing cultural and temporal gap between the creation of historical artworks and modern viewers, and partially as a factor of expression depiction conventions in paintings evolving to become more accurate. Although the current study is not an analysis of the artworks' formal features, we aim to study the artists' depictions through the lens of modern perception. Inconsistencies in participants' categorisation may reveal changing emotional schemas or depiction conventions. Second, we hypothesise that unambiguous facial expressions lead to a stronger emotional impact of the entire painting. In other words, we are interested in how the clarity of depiction of individual facial expressions within a painting contributes to its overall expressiveness.

## 6. Method

### 6.1. Participants

The study included 152 participants: 69 men, 81 women, and two nonbinary people. All participants were between 18 and 64 years old, with the largest age group being adults between 25 and 34 years old (44%), and the second-largest group being between 18 and 25 years old (32%), followed by 35 to 44 years old (16%). The majority identified as Christian (56%), with atheists (22%) and agnostics (14%) making up the next-largest groups. The remaining participants identified as Muslim (1%), Hindu (1%), and other religions (6%). Participants were recruited through the recruitment platform Prolific and were compensated €3.00 for an approximate duration of 20 minutes. The study accepted adults from all countries, if they spoke fluent English and had a Prolific approval rate of over 95 with at least 100 submissions. Before data collection, ethical approval was obtained from Utrecht University under the code 24-1895.

We wanted to collect 30 judgements per painting. Each participant judged 11 paintings (with six faces on average) to ensure an experiment duration of about 20 minutes. For a total of 56 paintings, we thus needed 1680 judgements which amounted to about 153 participants.

### 6.2. Materials

Data can be accessed at the 4tu.nl data repository: <http://doi.org/10.4121/361c5050-9c49-4832-994c-116b4282a062>

### 6.3. Picture Collection

Paintings of the 'Adoration of the Shepherds' and the 'Lamentation of Christ' were included due to their thematic and compositional similarities, but the collection will continue to be referred to as Nativity and Pietà for simplicity.

The selection for the final dataset was made from a pool of around 260 paintings. These paintings were gathered from searching online datasets such as Wikimedia Commons and Google images for keywords like ‘Pietà paintings’, ‘Nativity paintings,’ ‘Lamentation of Christ’, ‘Adoration of the Shepherds’, etc. Both sources were manually scanned by the researcher, and the final selection of paintings taken from these sites fit the criteria of being:

1. Made between the 11th and 19th century;
2. Finished paintings;
3. Pictures featuring more than two visible faces aside from Christ;
4. In clear resolution (e.g. not less than or noticeably less than  $1280 \times 720$ );
5. Shown in good condition (e.g. not heavily damaged or photographed from an angle).

The paintings did not need to be by renowned artists; anonymous works and those with minimal historical significance were also included. Paintings with unclear production dates were also accepted if there was a general estimate, due to the common lack of exact documentation. If the dates were estimated as a range, then the year in the middle of the range was used. If there was only an estimation of century, then the year in the middle of the century was used, while if the estimation mentioned early or late century, then 1X25 or 1X75 were used as the recorded dates. It turned out that for the Pietà theme we could not find paintings from before the 14th century while for the Nativity data we did. As we believe the early Nativity paintings are valuable for our study, but as we also wanted to make fair comparisons between the themes, we decided to analyse the data with and without the pre 14th century paintings.

As mentioned in the introduction, this is a ‘distant viewing’ study that uses human vision instead of computer vision annotations. The disadvantage of using human vision is scalability primarily caused by budgetary restraints. Because we wanted about 30 human judgements per painting, we only had funding for a subsample of 56 pictures (29 depicted Nativity scenes and 27 Pietà scenes). These pictures were chosen quasi-randomly as we aimed for an even distribution across years. This need for representative sampling, instead of studying a complete set, resembles the challenge of studying a human-participants sample that represents the whole (or a subgroup) of humanity. While studies on humans are well established and come with guidelines about sampling and statistical power, there is no established convention for pictorial research.

#### *6.4. Stimulus Preparation*

Photoshop was used to edit each painting with numbers and arrows that pointed to the characters’ faces. As the experiment aimed to study the facial

expressions in paintings with multiple characters, it was necessary to consistently label each face. However, faces that were mostly turned away from the viewer, or small and in the distance, were not included as part of the labelling. Additionally, the face of the infant Christ was excluded, as it was often very small or lacked any expressive emotion to speak of, to the discretion of the researcher. After a pilot experiment we found that observers also had difficulty judging the emotion of the ‘Pietà Christ’, partly because the deceased face is often expressionless. Hence, we also skipped these faces. All other faces were labelled with numbers.

Simple arrow symbols were used to indicate which face each number corresponded to. The arrows were placed very close to the numbers and pointed to each face as clearly as possible without obstructing the view of any important elements, such as other characters. These two elements were coloured white and included a soft drop shadow effect to draw more attention to them. Where possible, the white numbers and arrows were placed in front of areas with higher contrast for better visibility. If there were more than 10 characters present in one painting, the faces of those that were turned fully to the side or heavily shadowed were not considered. All other visible faces were labelled (see Section 6.2. *Materials*). In the end, the lowest number of faces per picture was three, the highest 14, and the median five.

### 6.5. Procedure

Participants followed the link to the Qualtrics survey through the Prolific platform. Upon clicking the link, participants were directed to an information and consent page with short explanations of the study and tasks. They were also notified that the first part of the study (assessing individual faces) would take the most amount of time compared to the second (assessing overall expressiveness). After consenting to participation, participants were presented with three demographics questions and later instructions for starting the emotion matching part.

As it would take too long to show all participants the full dataset, the images were split up so each participant would only see 11 paintings. The “Advanced Question Randomization” from Qualtrics was used to randomly present 11 of the 56 question items to each participant in a balanced way.

In the first block, participants were asked to label the facial expressions in each painting with one of ten emotion categories: joy, sadness, anger, fear, surprise, disgust, interest, love, contempt, or neutral. Participants used the drag-and-drop function to assign faces to emotions. All faces had to be assigned to an emotion, and one face could not be assigned to more than one emotion. Due to reported confusions after a pilot study on what ‘contempt’ meant, with some people mistaking it for ‘content’ and others not being familiar with the word, in this study it was defined in the instructions (i.e. “Contempt = lack of

respect; the feeling or attitude of regarding someone or something as inferior; scorn”). The other emotion labels were not further explained. The instruction page indicated that participants should try to ignore the scene context as much as possible and focus on the emotion of the individual faces. This message was underlined and in italic.

The second block concerned the overall expressiveness of the paintings. Specifically, participants were asked to evaluate how effectively or intensely the painting communicates its emotional content and were told to answer by dragging the slider from 1 to 100. While participants only saw one painting at a time in the first part of the study, in the intensity portion they could view all the images on the same page without having to click next. This allowed for a more comparative assessment between pictures.

### 6.6. *Data Analysis*

We first performed a descriptive analysis of the emotion categorisation data and then converted these categorical data into the scale data variables of polarity, agreeability, ambiguity and intensity.

Polarity was defined on a scale from 1 to  $-1$ . Following the Geneva Wheel of Emotions framework, the positive emotions were joy, love, interest and surprise, while the negative emotions were sadness, anger, contempt, disgust, and fear (Scherer *et al.*, 2013). Polarity was calculated by assigning positive emotions a weight of  $+1$ , the neutral emotion a weight of  $0$ , and the negative a weight of  $-1$ , and then divided by the total number of judgements. Thus, if 15 people answered ‘joy’, 5 ‘neutral’, and 10 ‘sadness’, the polarity would be  $0.17$ .

Agreeability was defined as the highest percentage of participants who selected the same emotion category for the same face. For example, if 40% of people selected ‘joy’, 30% selected ‘interest’, and 30% ‘neutral’, then the agreeability for that image would be 40%.

Ambiguity is defined as the number of different emotions that were chosen per face. The theoretical maximum is 10 and minimum is one. If the facial expression is ambiguous, it is likely that observers choose various emotions, hence the term ambiguity.

Intensity was based on the second experimental block where participants rated the overall intensity of the paintings on a scale from one to 100.

To assess statistical differences in mean agreeability, polarity and intensity we used Welch *t*-tests in order to anticipate on unequal variances in the Pietà and Nativity groups. The non-integer degrees of freedom is a consequence of the Welch test.

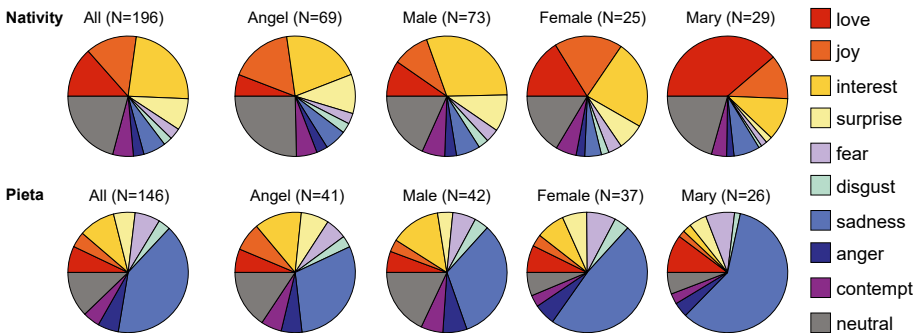
To compute temporal changes of polarity, agreeability, ambiguity and intensity we conducted linear regressions with creation year as independent

variable, separately for Nativity and Pietà themes. For polarity, agreeability and ambiguity we conducted the linear regression on a face basis (since we could compute these two variables per face), while for intensity we conducted the linear regression on a painting basis.

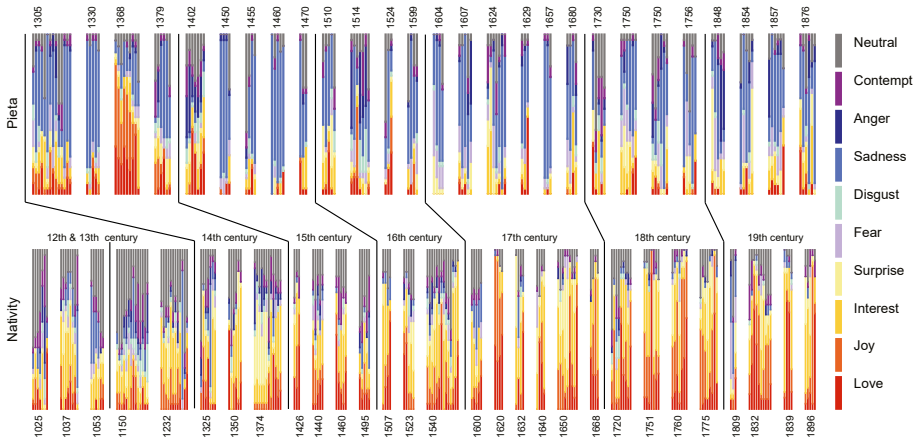
## 7. Results

On the left side of Fig. 1 we visualised the overall facial expressions for all paintings of the two themes. It can be readily inferred that sadness dominates Pietà paintings while the positive emotions found in Nativity paintings are distributed over love, joy, interest and surprise. Furthermore, there seems to be an interesting difference in neutral faces which occur more often in Nativity than in Pietà paintings. In the remainder of Fig. 1 we split up the faces in subgroups of sex. As it is not clear which sex angels belong to, we created a separate category for them. Furthermore, due to her consistency and unique status in the theme, Mary seemed to be a special case that we deemed interesting to compare with other females and thus isolated from the rest. One of the more salient sex differences between males and females in the Nativity paintings was that females expressed more love and joy. Moreover, Mary's expression was dominated by love. For the Pietà paintings the neutral expression occurred more often on faces of angels and males than on females and Mary. The opposite was the case for sadness, which was higher for females and Mary.

To understand whether the above observation also hold on the individual painting level, we created the visualisation presented in Fig. 2. Firstly, the dominance of sadness in Pietà paintings indeed persists over many paintings, as does the combination of love, joy, interest and surprise in Nativity paintings.



**Figure 1.** Pie charts of the overall facial expression throughout all paintings from the two themes Nativity and Pietà. The left column shows the overall scores, the other four columns split the faces up in Angel, Male, Female and Mary.



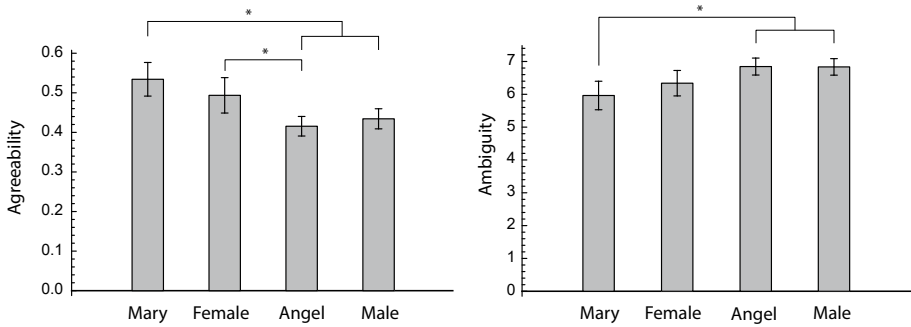
**Figure 2.** Emotional spread per picture, ordered by Pietà (top), Nativity (bottom) and Time (horizontal ordering).

Secondly, the 12th and 13th century Nativity paintings seem to contain relatively many neutral faces. This marks a difference from Pietà paintings which seems to persist over later centuries although small. We verified this difference statistically by conducting a Mann–Witney test on all faces from 1300 onwards and found that Nativity paintings (median = 0.15) indeed depicted more neutral faces than Pietà paintings (median = 0.07):  $U = 13818$ ,  $n_{\text{Nativity}} = 149$ ,  $n_{\text{Pietà}} = 146$ ,  $p < 0.001$ .

Thirdly, there seems to be an outlier in the Pietà set: the painting dated 1368, which contains many positive emotions such as love and joy. We verified that this was not a mislabelling, it was Simone di Filippo’s *Pietà with Angels* and indeed the six angels appear to express positive emotions and Maria (the 8th bar) appears to express love. All pictures and data can be found in the supplementary material for further investigation (see Section 6.2. *Materials*).

The categorical emotion data were converted into the scale variables polarity (relative amount of negative/positive emotions), agreeability (ratio of most chosen emotion to all choices), and ambiguity (number of different chosen emotions) and analysed together with the intensity ratings. Pietà and Nativity paintings were analysed separately for differences in their polarity, agreeability, ambiguity, and intensity. As expected, Nativity paintings showed a positive polarity ( $M = 0.43$ ,  $SD = 0.32$ ) while Pietà paintings a negative polarity ( $M = -0.37$ ,  $SD = 0.26$ ), resulting in a significant difference ( $t_{53.2} = -10.233$ ,  $p < 0.001$ ,  $d = 2.715$ ) as revealed by a Welch’s  $t$ -test.

Pietà paintings on average have higher means on agreeability ( $M = 0.51$ ,  $SD = 0.12$ ) compared to Nativity paintings ( $M = 0.42$ ,  $SD = 0.07$ ,  $t_{42.8} = 3.31$ ,  $p < 0.005$ ,  $d = 0.892$ ). An important consideration in this result is the high number of faces showing sadness as their primary emotion in Pietà paintings,



**Figure 3.** Mean Agreeability and Ambiguity data split per sex. Mary was assigned a special category and for angels it was not sure what sex they would represent, hence they were also assigned a separate category.

compared to the positive emotions in Nativity faces being more evenly distributed among the four categories.

There was no significant difference between the ambiguity of Nativity paintings ( $M = 6.531$ ,  $SD = 1.062$ ) and Pietà paintings ( $M = 6.262$ ,  $SD = 0.971$ ) as shown by the Welch  $t$ -test ( $t_{51,99} = 0.971$ ,  $p = 0.335$ ,  $d = 0.275$ ).

In terms of intensity, Pietà paintings ( $M = 61.55$ ,  $SD = 11.26$ ) are rated higher by participants compared to Nativity paintings ( $M = 49.15$ ,  $SD = 14.70$ ) which was statistically confirmed ( $t_{52,1} = 3.557$ ,  $p < 0.001$ ,  $d = 0.947$ ).

To understand the relation between sex of the portrayed and the scale variables, we conducted ANOVAs and post-hoc Bonferroni-corrected  $t$ -tests on the variables agreeability and ambiguity. We could not conduct this analysis on the intensity data as that is not linked to individual faces. Polarity was not taken into account because we would need to split the data into Pietà/Nativity groups which would dilute the data. In Fig. 3, the results for the mean agreeability and ambiguity data can be seen. For agreeability the ANOVA was significant ( $F_{3,338} = 9.921$ ,  $p < 0.001$ ,  $\eta^2 = 0.081$ ) and pairwise comparisons revealed a significant difference between female and angel, as well as between Mary and both angel and male. For ambiguity the ANOVA was also significant ( $F_{3,338} = 6.19$ ,  $p < 0.001$ ,  $\eta^2 = 0.052$ ) and we likewise found a significant difference between Mary and both angel and male.

To investigate how facial expressions evolved through time, we performed linear regressions on the polarity, agreement, ambiguity and intensity data with painting creation date as the independent variable. For polarity we conducted the regressions separately for the Nativity and Pietà paintings. For the other dependent variables, we additionally performed the analysis on the aggregated data, labelled as ‘Together’ in Table 1. Figure 4 shows the polarity, agreement, ambiguity and intensity data split per Nativity/Pietà. The error bars denote the standard deviation over all the faces from the painting except

**Table 1.**

Results of linear regression analyses for each variable as a function of creation year.

Variable	Theme	Slope	<i>t</i>	df	<i>p</i>	<i>R</i> <sup>2</sup>
Polarity	Pietà	$-2.8 \times 10^{-4}$	-1.527	145	n.s.	0.02
	Nativity	$9.0 \times 10^{-4}$	9.911	195	<0.001	0.34
Agreeability	Pietà	$-2.4 \times 10^{-6}$	-0.029	145	n.s.	<0.01
	Nativity	$5.7 \times 10^{-5}$	1.675	195	n.s.	0.01
	Together	$6.8 \times 10^{-5}$	1.882	341	n.s.	0.01
Ambiguity	Pietà	-0.0011	-1.527	145	n.s.	0.02
	Nativity	-0.0018	-4.746	195	<0.001	0.10
	Together	-0.0017	-4.917	341	<0.001	0.07
Intensity	Pietà	0.023	4.56	802	<0.001	0.03
	Nativity	0.044	12.07	857	<0.001	0.15
	Together	0.041	14.05	1660	<0.001	0.11

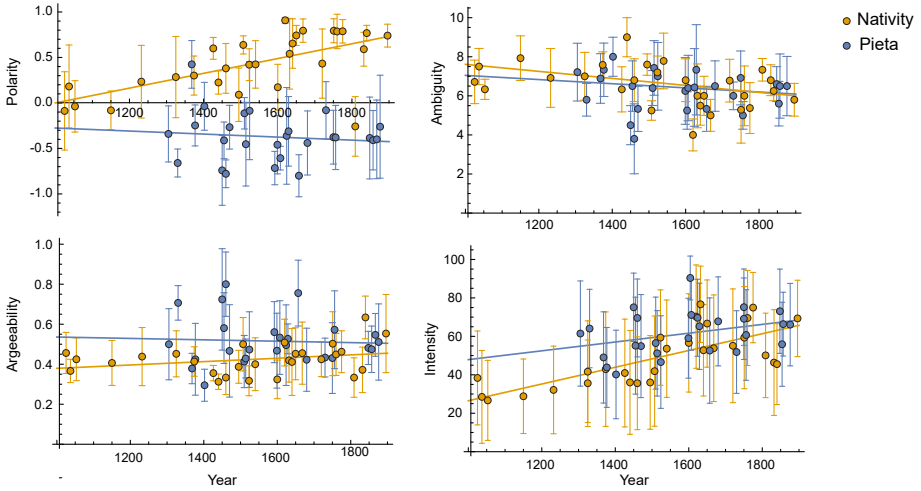
for the intensity data where the error bars denote the standard deviation of the 30 ratings per painting. For polarity, a linear change over time can be observed quite strongly for Nativity scenes but less clear for Pietà scenes. In Table 1 we indeed find that Nativity showed a significant slope, while Pietà did not.

One clear difference between the Nativity and Pietà paintings is that we did not have Pietà scenes from before the 14th century. As the clear positively sloped trend of polarity for Nativity scenes seems to substantially rely in the low polarity before the 14th century, we performed the same analysis on the data while leaving out paintings before the 14th century. Although the coefficient of determination decreased to  $R^2 = 0.16$ , the slope was still significant ( $t(148) = 5.3$ ,  $p < 0.001$ ) and roughly maintained its value (from  $9.0 \cdot 10^{-4}$  polarity/year for the original data to  $8.1 \cdot 10^{-4}$  polarity/year in the capped data).

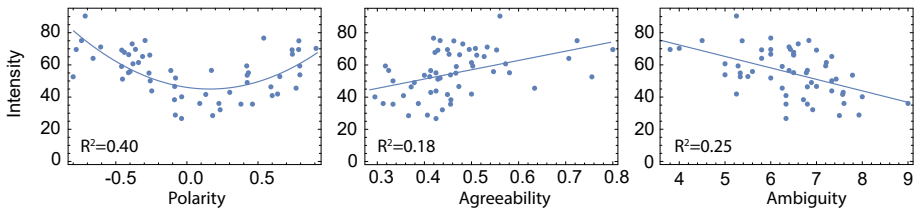
The agreeability data do not show a trend which is confirmed by the statistics in Table 1. However, for ambiguity we find a clear decrease in time for the complete painting set ('Together') and also for the Nativity subset as is visible both in Fig. 4 and confirmed in Table 1. Thus, fewer emotions were chosen for more contemporary paintings.

For the intensity data, the linear regression revealed significant upward trend, although the effect size as quantified by the coefficient of determination was relatively low. When taken together, the creation year explained 11% of the intensity rating variance. Given the high variances within each painting (as shown by the error bars denoting standard deviations), which obviously cannot be explained by creation year, the magnitude of coefficient of determination is quite substantial.

Lastly, we looked at the relations between the facial expression scale variables and the overall intensity of each painting. For polarity we fitted a second-order polynomial while for agreeability and ambiguity we fitted a



**Figure 4.** Relation of Polarity, Agreeability, Ambiguity and Intensity with time. Top left: Polarity per painting with error bars based on individual faces in each painting. A clear upward trend can be seen for the Nativity paintings. Bottom left: Agreeability was mostly constant throughout time. Top right: Ambiguity decreases with time. Bottom right: Intensity (error bars denote standard deviation of the participant ratings) showed a clear upward trend for the Nativity paintings and to a lesser extent for Pietà paintings.



**Figure 5.** Scatter plots and model fits of Intensity as a function of Polarity, Agreeability and Ambiguity.

first-order (linear) polynomial. As can be seen in Figure 5, the coefficient of determination for polarity is rather high ( $R^2 = 0.40$ ) and shows a clear relation with the overall perceived emotional intensity of the painting. Both the linear ( $F_{1,53} = 5.25, p < 0.05$ ) and the quadratic ( $F_{1,53} = 29.75, p < 0.001$ ) terms were significant. Agreeability ( $F_{1,54} = 11.84, p < 0.005$ ) and ambiguity ( $F_{1,54} = 17.89, p < 0.001$ ) also have significant relationships with intensity.

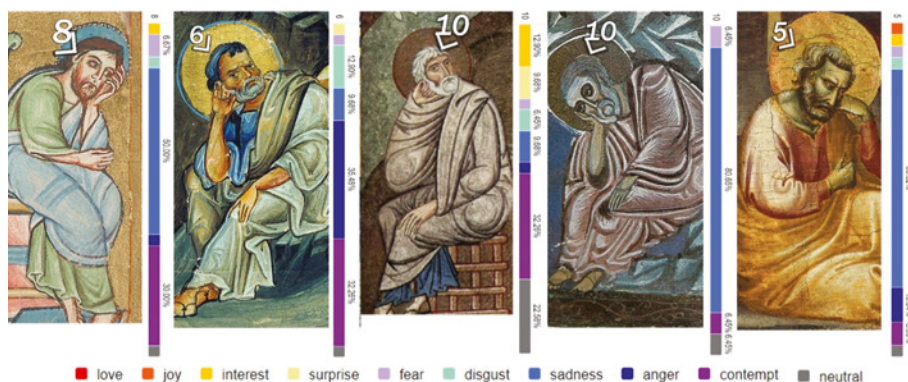
## 8. Discussion

This study aimed to understand the perception and depiction of facial expression in paintings throughout time. To have some control over the subject matter we chose two typical western art themes that have a clear relationship to emotions: the birth (Nativity) and death (Pietà) of Christ. We let observers select one of 10 emotions per face, while they were instructed to ignore the overall scene and focus only on the face. Furthermore, we asked observers to rate the overall emotional intensity of the paintings. The facial expression categories were converted into the scale variables polarity, agreeability and ambiguity.

As expected, we found differences in average polarity between the Nativity and Pietà paintings, meaning Nativity paintings depicted more positive emotions than Pietà paintings. Furthermore, Pietà paintings scored higher in agreeability and intensity. The higher agreeability is likely explained by the dominance of sadness in Pietà paintings, while the positive emotions in Nativity paintings were distributed across love, joy and interest.

To investigate a possible relation between facial expression and sex of the portrayed, we split the data into female and male and in addition added the categories angel and Mary. Previous research indicates that female expressions are judged more accurately (Wells *et al.*, 2016). We did not measure accuracy as we do not have the ground truth data, but agreeability and ambiguity are both related to precision, which in the case of unbiased perception would be related to accuracy. Indeed, we find an effect, although it is mostly related to how Mary compares to males and angels: Mary is most agreed upon, and least ambiguous. However, for the general female faces, we only find a difference with angels, and no direct differences between males and females. Hence our findings do not replicate Wells *et al.* (2016).

In terms of the relationship to time, Nativity paintings showed a mostly linear relationship in polarity increasing and plateauing around the end of the 17th century, while polarity in Pietà paintings did not have a significant relation with time. The relationship between intensity and year suggests a linear increase in intensity over time for Nativity, but not necessarily for Pietà paintings. Furthermore, the results indicate there is no relation between agreeability and time. However, there was a clear relation between ambiguity and time: facial expressions become less ambiguous for more recent depictions. There may be two related causes for this effect. Firstly, from the 12th century onwards, painters gradually become ‘better’ at depicting reality, including human bodies and their faces. It seems plausible that this mastery would translate to depicting unambiguous facial expressions. Secondly, if there were a certain amount of convention around facial expression depiction, it



**Figure 6.** Joseph featured in pre- and early 14th century Nativity paintings. On the right of each cropped image is the aggregate result of opinions on the emotion displayed.

would be plausible that younger paintings would be less ambiguous than older paintings.

In an absolute sense, the agreeability generally shows low rates: average agreeability is around 0.5 (i.e. only half of the participants choose the same emotion) and all except four Pietà paintings scored below 0.7. This suggests increased uncertainty in people’s views of what emotion a painted facial expression shows compared to photographs of faces with around 80% agreement rates (Dores *et al.*, 2020). It should be noted that this agreement rate relates to the ground truth label, which is different from our study (as we do not have ground truths) although in practice it comes down to the same if ground truth is defined as the emotion chosen most often.

Linking the variables over time could provide valuable insights into the way that painters utilised different techniques in depicting each artwork. For example, polarity in Nativity pre- and early 14th century paintings is shown to be largely neutral. One contribution to this result is a characteristic of this period’s paintings: Joseph is featured in almost all the paintings of that time and is mostly agreed to display sadness, contempt, or anger (Figure 6). Indeed, Baxandall (1988) accounts that in the 14th century [...] “S. Bernardino of Siena complained in one of his sermons that painters showed St. Joseph in the Nativity resting his chin on his hand [...], indicating melancholy; but Joseph was a cheerful old man, he says, and should be shown so.” Given that Maria’s son was not his, it is conceivable that he expresses negative instead of positive emotion. In addition, it is possible that the face of Mary around the time of Giotto would be interpreted as scared as she would one day lose him (Gurney, 2020), although we did not find this pattern in the overall results of Mary displayed in Fig. 1. Gradually through the years, polarity seems to increase, suggesting that Nativity art works start to make use of exclusively positive

emotions. Moreover, the plateau effect from the 17th century to the 19th century might represent only a reasonable maximum as the polarity reaches around 0.75. Lastly, a drop in agreeability from the start of the 15th to the end of the 16th century in Nativity paintings matches quite well with a drop in intensity at the same time, indicating the techniques or styles utilised at this period might have been less expressive.

When analysing Pietà paintings over time, the evolution appears more scattered and variable. This variability can be attributed to several factors, including differences in painting styles for this theme, the coexistence of different manners of painting it in the same period, or the random selection of a more diverse range of images compared to Nativity. However, one notable observation is that both polarity and intensity peak from the 15th to the 17th century, earlier compared to Nativity paintings, and then gradually decrease.

In the entirety of paintings, there is significantly higher agreeability in the emotion of sadness and in Pietà scenes. Although it is likely that artists were more skilled at depicting sadness or that sadness is more easily identified by viewers, this is not necessarily the conclusion. It may be that the inherent grief in these paintings is more easily attributed to sadness than to a variety of negative emotions, thus naturally resulting in higher agreeability. However, as the mixed emotions in Nativity paintings also show lower agreement per face, this suggests that people have more difficulty recognising specific depictions of love, interest, surprise, and joy than they do of sadness. This stands in contrast with previous studies on human facial expressions that show happiness as the easiest emotion to identify and sadness as considerably more difficult (Chafi *et al.*, 2012; Dores *et al.*, 2020; Martinez and Du, 2017). Nonetheless, even those findings are somewhat inconsistent, and other research by Keltner and Cordaro (2017) shows the opposite. Future research might be needed to clarify whether sadness was indeed easier to depict and understand in historical paintings.

A potentially far-ranging choice we made was to show the faces in their original context, the pictorial scene. This allowed for the possibility of various contextual cues to influence the facial expression recognition task. Righart and de Gelder (2008) showed faces in congruent and incongruent contexts and, as may be expected, found that context affects facial expression recognition. The stimuli used in that study showed photo collages of cut-out faces superimposed on various scenes. Given that in paintings there is a natural congruency (the face is attached to a body which is positioned in pictorial space), the effect may be even stronger than predicted by Righart and de Gelder (2008). Studying the relation between motif and background is a very intriguing future venue for studies on art and perception, yet it was beyond the scope of our current project.

Lastly, we found a relation between polarity, agreeability and ambiguity with the measure of each painting's intensity of expressiveness. The polarity finding suggests that the less neutral and the more uniform the faces are, the more emotionally intense the overall paintings will be. This is in line with our hypothesis that the individual faces contribute to the overall intensity. The relation with agreeability and ambiguity suggests that paintings which are more intense consist of expressions which are easier to agree upon and less ambiguous, and paintings which show more clarity of expression will be perceived as more intense. This is consistent with a study by Palermo and Coltheart (2004) who showed that expressions of photographed people were easiest to understand when the faces displayed it more intensely. In our study using paintings, this does not directly relate to the intensity of each face, as that was not measured, but potentially the clarity and skill in depiction could make them easier to define and in turn stronger. Interestingly, although these variables are linked, we see a plateau and a downward trend effect in agreeability after a certain period that is not present in intensity through time. This is consistent with paintings of around the 17th century starting to utilise different techniques to improve expressiveness that are unrelated to facial expressions.

In conclusion, this study provides insights into emotion recognition and depiction in Pietà and Nativity paintings. Pietà paintings exhibited higher intensity and agreeability, and a significant relationship was found between polarity and intensity and agreeability and intensity. This implies that uniformity and clarity of facial expressions increases the overall intensity of expressiveness perceived in the painting. The findings also suggest consistent agreement levels over time, suggesting modern audiences do not necessarily view facial expressions in older paintings with any more difficulty than in newer ones. Lastly, changes were found in polarity and intensity across time, pointing to different trends of painting Nativity and Pietà scenes. These findings have valuable implications for art history and emotion recognition fields.

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