

A computer vision-aided analysis of facial similarities in Song dynasty imperial portraits

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Abstract

Similarity between faces in portraiture is incredibly informative for art historical questions involving the sitter's identity, as well for setting a painting in its historical context to understand why someone was depicted a certain way. A set of royal portraits from Song dynasty, China, has been the subject of rich art historical scholarship. Here, I demonstrate the usefulness of computer vision-based quantitative metrics in complementing existing rich subjective evaluations. Working with the portrait set, I show that L2 distances generated by OpenFace support the accepted hypothesis that emperor Lizong is depicted in *Listening to the Wind in the Pines*. I then use the technique to gain insight into whether the zither player in *Listening to the zither resembles emperor Huizong* and why that might be, as well as what degrees of similarity between emperor portraits in the set may mean in terms of metaphorical inclusion or exclusion from the lineage. I then extend discussions on metaphorical inclusion to women in this set by exploring spousal similarity. Fascinating mysteries surrounding posthumous portraiture float amidst confounding factors in the clouds of memory, and this study shows the promise of using computer vision-based techniques as complements to subjective analyses in exploring these mysteries.

Introduction

Posthumous portraiture oriented towards ritual veneration and created out of memories is a class of paintings that tells us not only about the subjects being remembered, but also about those doing the remembering, as well as the times of both the remembered and the remembering. In posthumous imperial portraiture, the role of those doing the remembering becomes even more pronounced, as due to the heightened importance of physiognomy, construction (e.g. of a godlike presence) takes on a more important role as opposed to mere capture of likeness [15].

The set of album-sized paintings shown in Fig.1 (National Palace Museum, Taipei, Open Data) is a group of portrait images of Song Dynasty emperors and empresses. These portraits may have been studies for a set of seated portraits, which in turn likely belong in the branch of ancestral portrait paintings [2]. The set is nearly complete; it is missing portraits of empresses of Taizu, Taizong, Lizong, and Duzong. There is convincing evidence that these portraits were ancestral paintings painted posthumously and hung in ancestral halls for ritual veneration, and the portraits have garnered interest and subjective analysis from art historians in relation to a wide range of hypotheses.

Patricia Ebrey's work provides insight into the historical and ritual contexts of these ancestral paintings. She points out that while the portraits of six earlier emperors show considerable variation in size and robe color, those of the ten emperors starting

from Shenzong are fairly consistent in size, robe color, and the direction in which the emperors face [2]. She further suggests convincingly, based on the observation that portraits of later empresses are also more uniform and are similar in size to portraits of their spouses, that these paintings may have been made as pairs [2].

There are a few records supporting the hypothesis that these portraits were painted posthumously. The full length hanging scroll seated portrait of Taizu, of which the album sized paintings were presumably studies, was painted posthumously: there are records that Mou Gu, a late 10th century leading court painter and "a specialist in the art of physiognomy", had been promoted in the Painting Bureau after painting the only successful posthumous frontal view of emperor Taizu [15]. Other examples are described by Heping Liu: Mou Gu also painted a frontal portrait of Taizong commissioned by Zhenzong (after the death of Taizong)[9]. Yuan'ai, who was known for paintings of Buddhist

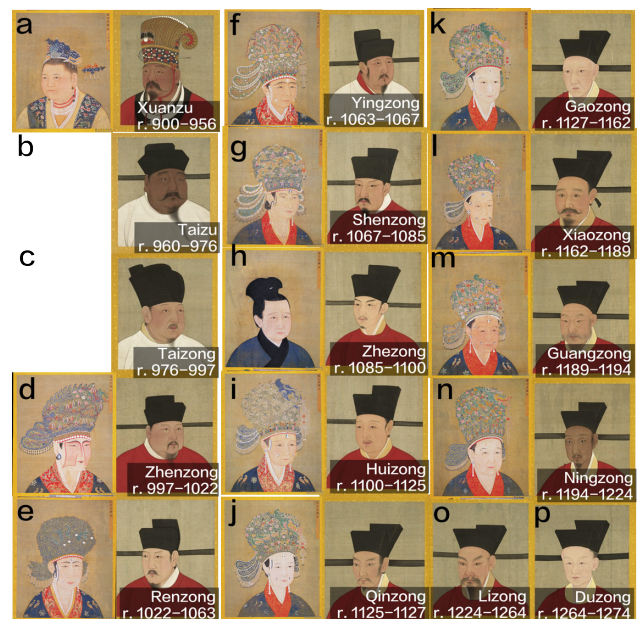


Figure 1. Surviving album-sized Northern and Southern Song dynasty imperial portraits that likely served as studies for a set of full length seated portraits. Arranged in pairs of empresses and emperors, labeled in chronological order by the emperor and year range of his reign. Qinzong (j) was the last emperor of Northern Song. Portraits of empresses of Taizu (b), Taizong (c), Lizong (o) and Duzong (p) are missing from the National Palace Museum Open Data database.

subjects, was also commissioned by Zhenzong to paint a memorial of Taizong[9]. Wang Duan was commissioned to paint a memorial portrait of Zhenzong after his death, and after Empress Dowager Liu's death, Renzong commissioned portraits of both Zhenzong and the deceased empress dowager[9].

Ebrey also notes the ritual significance of these paintings – they were likely “hung for religious rites in which descendants or their surrogates placed offerings”, and “people of the time referred to these paintings using the same terms they used for statues or paintings of deities housed in Buddhist, Taoist, and popular temples” [2]. It is likely that court artists painted them posthumously as one of many activities associated with funeral preparations [2]. The ritual significance of these paintings is underscored by efforts to preserve them during the years following the Jurchen sieges [2]. Wen Fong echoes Ebrey regarding the display of these portraits in state temples, adding that they at once served as ancestral effigies and scared icons, radiating a supernatural expressionism that influenced later formal portrait art [15]. Indeed, Fong suggests that these portraits aimed not only to capture physical likeness but also to display physiognomic characteristics of a godlike presence [15].

Some really interesting work has already been done on this set of imperial portraits. For example, Heping Liu has identified Zhenzong's empress depicted, who, as seen in Fig. 1d wears anomalous makeup, as Empress Liu (one of three possible empresses) [9]. He has further identified her unusual facial makeup, namely the application of pigment to the face from the eyebrows downward in the shape of rectangular leaves to look as if the face were covered by a thin gauze veil, as a revival of an archaism that can be traced back to the third century [9].

There is also an interesting study on furniture in these seated portraits where among other things, the author notes that Yingzong's throne is different from those of all other emperors, and that Shenzong's chair is similar in style to that of Zhenzong and Renzong as opposed to Yingzong[11]. Given the historical context that Yingzong was not Renzong's biological son but rather the grandson of Zhenzong's brother, and that Yingzong was a sickly emperor who only lasted four years on the throne and wasn't viewed too favorably, the author postulates that the reason Yingzong's seat stands out is for the purpose of metaphorically removing him from the lineage [11]. Ebrey offers an alternative hypothesis that does not necessarily contradict this one: on the grounds that Yingzong wears a white, less formal robe in his portrait unlike most emperors depicted wearing vermilion robes, she proposes that perhaps Yingzong's portrait may have been part of a different collection, particularly the collection of the Kaifeng Hall for Filial Longing for Imperial Forebears. How might these two hypotheses be disentangled? Given the importance of physiognomy at the time, are there insights we could gain into the question of whether Yingzong's face was intentionally depicted differently (metaphorically removed from the lineage) irregardless of whether the portrait may or may not have been painted by a different artist or for a different collection?

It is clear from scholarship on this set of portraits that there are a myriad of factors to consider, including but not limited to whether they were painted posthumously, the effects of idealization or incorporation of physiognomic lore, political motives for manipulation, and impacts of convention. While it is hard to come to definite conclusions given all these factors, it is valuable to add

to the repertoire of tools available in the exploration of these questions.

Herein, I demonstrate the use of OpenFace, an open source facial recognition framework, as a useful additional tool that complements subjective analysis in approaching art history questions relating to Song dynasty portraiture. OpenFace, which uses a deep neural network and is robust to factors like aging, head orientation, and facial expression [12], has previously been applied to track historical changes in trustworthiness in European portraiture[10]. Here, I use OpenFace similarity analysis to compare portraits within the set in Fig.1 as well as to compare selected portraits in the set with other Song Dynasty paintings that are of particular importance in art history. To validate the use of OpenFace in analyzing Song dynasty imperial portraits, I first show that OpenFace similarity analysis results support the generally accepted hypotheses that the emperor Lizong is depicted in Ma Lin's hanging scroll, *Listening to the Wind in the Pines*. Then, I use it to gain insight into three additional art history questions. I show that the zither player in Zhao Ji (Huizong)'s *Listening to the Zither* is less similar to Huizong's portrait than to other emperors. This, combined with the convincing art historical argument that the zither player is Huizong, suggests that perhaps Huizong, under whose rule Northern Song essentially collapsed, is portrayed as effeminate in his posthumous portrait. By evaluating relative similarities between portraits of Renzong through Huizong, I add insight into the hypothesis of Yingzong's metaphorical removal from the family lineage. Finally, by comparing similarities between empresses and their husbands, I identify couples who show the strongest and weakest resemblances and use these findings in discussing the hypothesis of using semblance to reflect inclusion or exclusion in lineage. It is difficult to make conclusive statements due to the vast number of confounding factors, but it is precisely this vast number of “principle components” that make these art historical questions surrounding these portraits immensely fascinating, and here I show that the more objective OpenFace analyses are valuable additions to the toolkit in navigating these questions and is an excellent complement to more subjective evaluations.

Methods

OpenFace, a facial recognition framework which uses a deep neural network, was chosen as the digital analysis tool. Facial recognition algorithms are designed to recognize people while controlling for transient parameters like age, background lighting, an orientation/camera angle. For this reason, they are designed to be robust to “aging, facial expression, head orientation, hairstyle, and image properties such as background and lighting” [12]. They are thus well-suited for the question I want to ask, which is whether we can identify anomalous facial depictions within this set of imperial portraits. OpenFace, the specific software used, identifies faces, transforms the face for fair comparison using OpenCV, uses a deep neural network to represent the face on a 128-dimensional unit hypersphere, and computes the squared L2 distance between their representations as a distance metric [1]. Essentially, the lower the distance score, the more similar the images [1]. Similarity analysis has previously been used for art history applications in identifying 2D and 3D depictions of young Leonardo da Vinci [13]. OpenFace has previously been applied in the context of art history to analyze and track historical changes

in trustworthiness in European portraiture [10].

The squared L2 distances between paintings is the main metric used in this work. Depending on the relevant hypothesis, distances were either computed between a face from another Song dynasty and each of the emperors' portrait in Fig. 1, or pairwise L2 distances were compared amongst the emperors or empresses in Fig. 1. Paintings outside the set of portraits in Fig. 1 used in this work include *Quietly listening to the wind in the pines*, 1246, 226.6 x 110.3 cm, Ma Lin, National Palace Museum, Taipei (available from NPM Open Data), and *Listening to the Zither*, Zhao Ji (Huizong), 1082-1135, 147.2 x 51.3 cm, hanging scroll, Palace Museum, Beijing (available from their website).

Results and discussion

Validating the use of OpenFace similarity analysis

The overlaying of current imperial visages onto historical, legendary, and religious paragons is a method to claim legitimacy of power, and, as Hui-Shu Lee discusses in her work, one Southern Song emperor who may have employed this strategy is Lizong (r. 1224-1264),[5] who ascended the throne under the pretext of the mysterious death of Ningzong's presumed successor.[6]



Figure 2. Facial distance score between the man in the detail from Ma Lin's *Listening to the Wind in the Pines* (a) and Lizong's portrait (b) is 0.757. Distance score to Lizong is indicated with a red arrow in the boxplot in c, from which we see Lizong has one of the lowest distance scores among all emperors.

Hui-Shu Lee discusses in her work the shared facial features between Lizong's imperial portrait (Fig. 1o) and Ma Lin's depiction of Fuxi (*Portrait of Fuxi*, Ma Lin, 249.8 x 112cm National Palace Museum, Taipei)[5]. She points out convincingly that clearly, Ma Lin's Fuxi was intended to bear semblance to Lizong – “square face, broad forehead, goatee, and, most distinctively, Lizong's long ‘phoenix’ eyes”[6]. Another proposed example of Lizong's self-association with the image of the Daoist sage is in Ma Lin's hanging scroll, *Listening to the Wind in the Pines* (detail of sage is shown in Fig. 2). This large hanging scroll bearing a seal of Lizong's Jixi Palace, may have been displayed in that hall, which would suggest, especially if the depicted man is Lizong himself, that by 1246 Lizong has fully and publicly adopted the Daoist way, casting himself as an “untrammelled individualist who communes with the mysteries of nature”[6].

Just by visual inspection of Fig. 2, we can already note some points of resemblance between the man depicted in Ma Lin's painting and Lizong's official portrait, including the uplifted phoenix eyes, the beard, and arguably even the squarish face shape. However, it is hard, based solely on visual inspection, to ask whether the man bears more resemblance to Lizong than to

other emperors. As we can see, with a score of 0.757 (Fig.2c), OpenFace was able to identify Lizong as one of the emperors that bear most resemblance to the man depicted in *Listening to the Wind in the Pines*.

Now that I've verified the utility of using OpenFace to quantify facial similarity in Song portrait paintings, I go on to use it in discussing another painting that may depict an emperor. Here, unlike with *Listening to the Wind in the Pines*, to the best of my knowledge, there is not as much agreement on whether it truly depicts an emperor. This next painting I look at is *Listening to the Zither*.

Using OpenFace similarity analysis to gain new insights into Listening to the Zither

In her book on Huizong, Ebrey states that the surviving official portrait of Huizong “was painted after Huizong's death to be hung during ancestral rituals performed in the palace” and was painted in Gaozong's court in the south [3], since Huizong died in captivity and the Jin did not notify Southern Song court of Huizong's death until 1137 [4]. By then, nobody in the south had seen Huizong in a decade, and the portrait “would have been based on how painters and other people at the court, including Gaozong, remembered him and wanted him portrayed” [3].

Keeping Ebrey's conclusions in mind, Cheng-hua Wang's hypothesis that the man playing the zither in *Listening to the Zither* (detail shown in Fig. 3), painted by Huizong, is Huizong himself, becomes all the more interesting.[14] Wang discusses some convincing points of support for this hypothesis. For example, she points out the hierarchical order in the painting, with the man playing the zither seated at the true north, facing southwards, as is the convention for the emperor[14]. Two ministers are seated, with the higher ranked one (determined based on color of dress) sitting on the left hand side of the man playing zither, and the lower ranked on to the right. She proposes, bringing into discussion the plants in the painting as well as Cai Jing's inscription, that in simultaneously depicting friendship and hierarchy, the painting creates an air of harmony between ruler and ministers[14].



Figure 3. Distance score between the zither player in Zhao Ji (Huizong)'s *Listening to the Zither* and selected imperial portraits. Boxplot (right) shows distance scores between the zither player and all emperor portraits in the set.

The arguments that Wang makes are all very convincing, but as Wang suggests, we run into an unavoidable question when discussing whether the zither player is Huizong: does the zither player look like Huizong's portrait in the collections of National

Palace Museum? Wang observes that scholars are divided on this question: some (e.g. Xu Dabang, Yang Xin) say that the zither player looks identical to Huizong's portrait (which I disagree with personally), and some (e.g. Wang Yaoting) think they do not look alike[14]. Wang uses this disagreement to rightly point out that arguments based off facial resemblance can be shaky because they are often subjective.[14] The arguments she makes are thus mostly from other angles, and she adds that a rebuttal to those who claim the zither player is not Huizong due to lack of resemblance could be that the Huizong depicted in *Listening to the zither* is an aged Huizong[14].

Here, I take a slightly different approach. Rather than assuming accuracy of Huizong's portrait and debating whether the zither player is Huizong, I think Wang's work makes a very convincing argument that the zither player is indeed Huizong. So instead I first want to discuss *Listening to the zither* in relation to Ebrey's hypothesis that Huizong's official portrait might be created from blurrier, more distant memories. Then, I want to discuss a potential insight in relation to Shao and Tao's hypothesis of intended removal of Yingzong from the family lineage in their work on furniture in these portraits.

I have juxtaposed a detail of the zither player with portraits of Huizong, Shenzong, and Renzong in Fig. 3. Disregarding Renzong for now, when I first viewed *Listening to the zither* alongside the imperial portraits, I thought the zither player bears much more resemblance to Shenzong (Huizong's father) than to Huizong. The slightly upward tilt of the eyes, the shape of the eyebrows, the style of the facial hair all contributed to my observed similarity between the zither player and Shenzong.

Since OpenFace was able to detect similarity between two different depictions of Lizong in the case of *Listening to the wind in the pines*, I deployed it again for this painting. The boxplot in Fig. 3 shows the distance scores between the zither player and each emperor portrait. Also seen in Fig. 3, Huizong's portrait resulted in a distance score of 0.5, which, corroborating my subjective observations, makes him one of two emperor portraits in the set that the zither player is least similar to. Also corroborating my subjective observations, Shenzong's portrait resulted in a distance score of 0.2, making him one of two emperor portraits in the set that the zither player is most similar to.

If we further assume that Wang is correct in identifying the zither player as Huizong (thus making it a self portrait of sorts), then these results could be said to corroborate Ebrey's hypothesis. Specifically, it is possible that Huizong, especially Huizong's eyes, looked more like the depiction in *Listening to the zither* as opposed to in his official portrait. Another way of framing it is perhaps Huizong looked more like his father Shenzong than is depicted in his official portrait. Or perhaps, taking into account the importance of physiognomy at the time, perhaps due to Northern Song having essentially ended under him, he is portrayed as more effeminate and "soft" for metaphorical purposes rather than accurate portrayal. Or perhaps, the effeminate portrayal was not intended but was rather a function of subconsciously distorted memory – perhaps when the word of his death finally reached the Southern Song court, memories of how Huizong looked like had been projected through the lens of knowing that he had died in capture and lost an empire. An additional result supporting the claim that Huizong is portrayed as more effeminate is the fact that when OpenFace was used to generate distance scores between

Huizong and all other emperors, the result is that his portrait is most similar to that of Duzong, another emperor seen by posterity as weak and irresponsible.

Now taking the discussion from the same starting point towards another direction, another interesting observation from Fig. 3 is that the L2 distance between Renzong and the zither player is also very low. This led me to another subjective observation that Shenzong's portrait resembles Renzong's portrait, which consequently brings me back to another contentious hypothesis about Song dynasty portraiture: Shao and Tao's hypothesis that Yingzong was depicted in an anomalous way to metaphorically remove him from the lineage [11].

The hypothesis of Yingzong's metaphorical removal from the lineage

Indeed, when we compare the portraits of Renzong through Huizong, we notice that even in terms of facial features, perhaps an argument could be made that Yingzong's portrait is an anomaly. Drawing particular attention to the eye region, Yingzong is depicted with eyebrows that are curved downwards and not so prominent and eyes that also curve downwards. This melancholic eye region depiction is similar to those of many empresses depicted in Fig. 1, and one proposal is that he is portrayed this way unlike most emperors because he was seen as weak, as Huizong was.



Figure 4. Pairwise distance scores between portraits of three generations of emperors. The three rows of distance scores are with respect to Shenzong, Zhezong, and Huizong, respectively (the score is zero between two identical faces)

However, there are many leaps in this proposal that are difficult to substantiate, and I think it is very difficult to prove or disprove the hypothesis that Yingzong's portrait was painted with the intention of metaphorical removal from the lineage. There are simply too many factors and too many choices that could have been made for too many reasons, with added layers of complexity brought up by Ebrey that 1) the painting could have been a replacement or painted for a different set, and 2) the paintings were commissioned posthumously for ancestral halls[2] (why would Shenzong, who was Yingzong's son, think about removing his father from the lineage when he was supposed to be mourning

him?).

However, I think the data shown in Fig. 4 does allow for an interesting conjecture on the topic of portrayal in portraits in relation to metaphorical continuity of lineage. Yingzong is not a biological descendant of Renzong, and the three ensuing emperors are all part of Yingzong’s biological lineage. Specifically, Shenzong is Yingzong’s son, and Zhezong and Huizong are both Shenzong’s son. Keeping this in mind, we can observe from Fig. 4 that Zhezong and Huizong’s portraits resemble each other – the shapes of their eye looks identical, as with their moustache. The shapes of their nose are also similar to each other. Further, the shape of their eyes resembles that of Renzong more than their father Shenzong or their grandfather Yingzong. The low distance scores between Zhezong and Huizong corroborates the statement that they are depicted with some features bearing resemblance.

Interesting, we can also observe from Fig. 4 that Shenzong, Zhezong, and Huizong all bear resemblance to Renzong. Huizong and Zhezong’s eyes look more like Renzong’s eyes than their father Shenzong’s eyes. Shenzong and Yingzong’s eyebrows resemble those of Renzong. Shenzong’s facial hair looks almost identical to that of Renzong. Again, the distance scores from OpenFace backs up this observation: Zhezong and Huizong resemble Renzong more than they do their father; Shenzong resembles Renzong more than he does his father or his sons. Perhaps through facial similarity, one thing this set of portrait achieved was to metaphorically include Shenzong and his sons in Renzong’s lineage.

Empress portraits: does level of resemblance to their husbands mean anything?

This last part of the work is a bit of a leap but could open doors for interesting future work. Hui-shu Lee’s work on Empress Yang’s art[5] and lady ghostwriters in the Song court[7] led me to ponder about women’s space and ways in which women’s legacy is discussed in a patriarchal world. In Lee’s discussion of women ghostwriters and Empress Yang’s calligraphy, she mentions that “good” handwriting was synonymous with writing that emulated that of respected male emperors[7]. Being “similar” to the emperor also brought political advantages. For instance, by “writing as Ningzong”, Empress Yang was able to cleverly get rid of Han Tuozhou[5], and by adopting the voice of the emperor, her ghostwriting becomes a service to herself[7]. But on the other hand, it is often not a good thing for females to be more powerful than their male counterpart. For instance, Lee also mentions that Empress Liu, an empress that rose from humble beginnings, was often blamed for the downfall of Northern Song[5]. Perhaps there is some legitimate reason for it, an example being her promotion of her own clan, but it is also difficult to deny the sad reality that in those times, even if the women “handled their duties with strength and wisdom”, they would still be blamed for failure of male leadership[5].

Thus, perhaps the best compliment for an empress would have been that she was a good supporting character in the her husband and/or son’s careers. Figuratively, perhaps analogous to emulating the calligraphy style of the emperor in ghostwriting, this could take the form of being portrayed in a manner that shows likeness to her husband, as the Chinese phrase 夫妻相, referring to physical resemblance between couples, is often used metaphorically to indicate a harmonious relationship.

Further, if these were indeed funerary portraits, then perhaps

the highest “honor” to give to a deceased female is to remember her as part of her husband’s legacy, to metaphorically include her in the lineage. Perhaps facial similarity could play a part in serving this purpose as well.

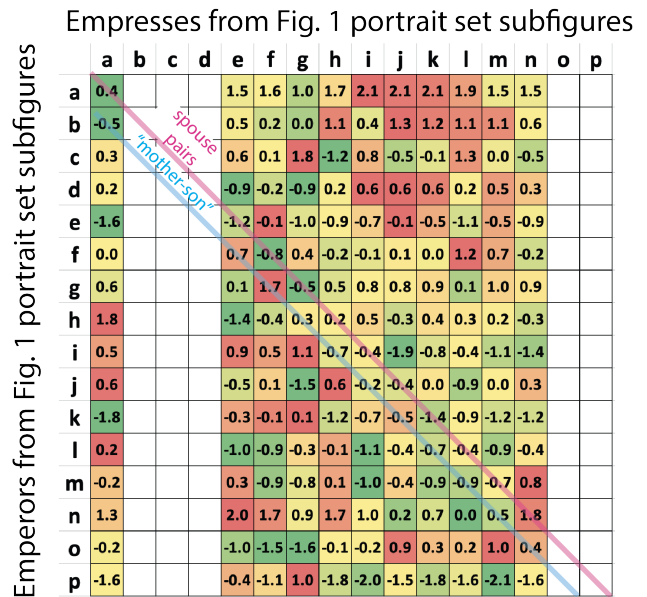


Figure 5. Normalized distance scores between each empress (columns) with each respective emperor (rows) from the portrait set in Fig.1. Column and row labels correspond to Fig. 1 subfigure labels. Empty columns result from missing empress photos (b,c,o,p) and the fact that the face of Empress Liu (d - Zhenzong’s empress) could not be detected from her portrait, likely due to the unusual makeup. The heatmap is colored by row (within each row, green would be the empress portrait with which the emperor portrait is most similar, and red would be the empress portrait with which the emperor portrait is least similar). The diagonal, illustrated with a pink line, indicates wife-husband pairs. The blue line offset by one row from the diagonal indicates “mother-son” pairs.

Fig. 5 shows the OpenFace normalized distance scores for all permutations of emperor-empress pairs in the set for which paintings survive and faces are identifiable by the software. A few cases on either extreme immediately arise, and the resemblances (or lack thereof) within these pairs are also quite apparent through inspection of Fig. 1. Couples that bear especially strong resemblance to each other according to OpenFace include Lady Du and Xuanzu, Lady Gao and Yingzong, and Empress Xiang and Shenzong. The couple that bears especially weak resemblance is Empress Yang and Ningzong. The weak resemblance between Empress Yang and Ningzong would make sense under the hypothesis that similarity is related to metaphorical inclusion in lineage and is correlated with being remembered fondly and respected after her death.

Turning our attention to the couples identified as bearing strong semblance, Lady Du was the “mother of all Song emperors”, being the first empress, so this also supports the hypothesis of using semblance as metaphorical inclusion in lineage. Lady Gao lived a long life and served as Empress Dowager during Shenzong and Zhezong’s reign. She was against Wang Anshi’s reforms, was very politically apt, and the thriving economy under

Zhezong was probably in large part thanks to her[8]. However, if Zhezong was the one who commissioned her painting, then perhaps this does not support the hypothesis of using likeness to include her in the lineage, because Zhezong did not seem to like how much power she had[8]. Empress Xiang also acted as the regent of both Zhezong and Huizong after the death of her husband, but it seems like she knew when to step down[3], so her bearing strong semblance to her husband in portraiture would also support the metaphorical inclusion hypothesis.

Again, it is difficult to arrive at definite conclusions in the context of what pairwise semblance might mean for emperor-empress portrait pairs. However, it is an interesting area for future work. In addition to emperor-empress pairs, it would also be insightful to look at emperor dowager - emperor (“mother-son” or “grandmother - son” pairs). Royal portraits for Yuan and Qing dynasties can also be found in NPM open data, and performing similar pairwise analyses on these datasets and setting the results in context with subjective analyses from art historians, as was done in this study, would also be extremely insightful. Perhaps with more data points, we can be more confident in whether these distance scores can help us draw more definite art historical conclusions.

Conclusion

In the space of portrait paintings, similarity between faces is an incredibly useful metric, both in answering questions involving the identity of a certain person in the painting, as well as in opening doors to questions involving why a certain person was depicted in a certain way. Here I have shown the usefulness of OpenFace (open-source deep neural network - based facial recognition) as an additional tool in both these art historical applications. I validated the robustness of the tool by confirming that OpenFace similarity results support the widely accepted art historical hypothesis that emperor Lizong is depicted in Ma Lin’s *Listening to the Wind in the Pines*. Then, I used similarity analysis to suggest new insights relating to Huizong’s *Listening to the zither* and official portraits of Huizong and his predecessors. I also used OpenFace to gain insight into the hypothesis that royal portraits served in part to illustrate metaphorical inclusion and exclusion from family lineage, both for emperors within the male line, and for empresses in terms of spousal semblance. The work presented here demonstrates the usefulness of computer-vision based similarity analysis as an additional part of the art historian’s toolkit in setting portrait paintings.

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References

[1] T. Baltrušaitis, P. Robinson, and L. Morency. “OpenFace: An open source facial behavior analysis toolkit”. In: *2016 IEEE Winter Conference on Applications of Computer Vision (WACV)*. 2016, pp. 1–10. DOI: 10.1109/WACV.2016.7477553.

- [2] Patricia Ebrey. “The Ritual Context of Sung Imperial Portraiture”. In: *Symposium on the arts of Sung and Yuan China*. Princeton University, 1996, pp. 69–89.
- [3] Patricia Buckley Ebrey. *Emperor Huizong*. Harvard University Press, 2014.
- [4] Herbert Franke and Denis Twitchett. In: *The Cambridge history of China, Volume 6: Alien regimes and border states, 907-1368*. Ed. by Denis Twitchett and John Fairbank. Cambridge University Press, 1994.
- [5] Hui-shu Lee. *Empresses, Art and Agency in Song Dynasty China*. University of Washington Press, 2010.
- [6] Hui-shu Lee. “West Lake and the mapping of Southern Song art”. In: *New York: China Institute Gallery*, 2001. Chap. *Exquisite Moments: West Lake and Southern Song Art*, pp. 19–59.
- [7] Hui-Shu Lee. “The Emperor’s lady ghostwriters in Song-Dynasty China”. In: *Artibus Asiae* 64.1 (2004), pp. 61–101.
- [8] Lily Xiao Hong Lee and Sue Wiles. *Biographical Dictionary of Chinese Women, Volume II: Tang Through Ming 618-1644*. Routledge, 2014.
- [9] Heping Liu. “Empress Liu’s “Icon of Maitreya”: Portraiture and Privacy at the Early Song Court”. In: *Artibus Asiae* 63.2 (2003), pp. 129–190.
- [10] Safra, L., Chevallier, C., Grèzes, J. et al. “Tracking historical changes in trustworthiness using machine learning analyses of facial cues in paintings”. In: *Nature Communications* 11 (2020), p. 4728.
- [11] Shao Xiao-feng and Tao Xiao-jun. “Study on furniture in the portraits of Song Dynasty’s emperor and empress”. In: *Hundred schools in art* 4 (2008), pp. 9–21.
- [12] Tea-makorn, P.P. and Kosinski, M. “Spouses’ faces are similar but do not become more similar with time”. In: *Scientific Reports* 10 (2020), p. 17001.
- [13] Christopher W Tyler, William A P Smith, and David G Stork. “In search of Leonardo: computer-based facial image analysis of Renaissance artworks for identifying Leonardo as subject”. In: *Human Vision and Electronic Imaging XVII*. Vol. 8291. SPIE, Feb. 2012, pp. 407–413.
- [14] Cheng-hua Wang. “《聽琴圖》的政治含義：徽宗朝院畫風格與意義網路 (Listening to Zither: Court Painting and Imperial Symbolism under the Reign of Huizong (r. 1101-1124))”. In: *Taida journal of art history* 5 (1998), pp. 77–122.
- [15] Wen C. Fong. “Beyond Representation: Chinese painting and calligraphy 8th - 14th century”. In: *New York: The Metropolitan Museum of Art*, 1996. Chap. *Sung Imperial Portraits*, pp. 141–145.

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