The Monocular Duke of Urbino

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ABSTRACT: Federico da Montefeltro (1422–1482), the Duke of Urbino, was a well-known historical figure during the Italian Renaissance. He is the subject of a famous painting by Piero della Francesca (1416–1492), which displays the Duke from the left and highlights his oddly shaped nose. The Duke is known to have lost his right eye due to an injury sustained during a jousting tournament, which is why the painting portrays him from the left. Some historians teach that the Duke subsequently underwent nasal surgery to remove tissue from the bridge of his nose in order to expand his visual field in an attempt to compensate for the lost eye. In theory, removal of a piece of the nose may have expanded the nasal visual field, especially the "eye motion visual field" that encompasses eye movements. In addition, removing part of the nose may have reduced some of the effects of ocular parallax. Finally, shifting of the visual egocenter may have occurred, although this seems likely unrelated to the proposed nasal surgery. Whether or not the Duke actually underwent the surgery cannot be proven, but it seems unlikely that this would have substantially improved his visual function.

KEYWORDS: Federico da Montefeltro, Duke of Urbino, visual field, ocular parallax, visual egocenter

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Introduction

Federico da Montefeltro (1422–1482), the Duke of Urbino, was an important figure in the history of the Italian Renaissance. He was celebrated for his wise governance, military prowess, and patronage of the arts. With his wife, Battista Sforza, he is the subject of a famous diptych by Piero della Francesca (1416–1492), which is one of the premier works at the Uffizi Gallery in Florence (Fig. 1). In the portrait, the Duke is portrayed from the left, and his nose is oddly shaped, with missing tissue at the nasal root. Federico is known to have sustained an injury to his right eye while jousting in a tournament in 1450, rendering him monocular. Most other surviving portraits of Federico also portray him from the left.

During a joust, the two riders converged, each along the left side of a barrier, so that the opponent's lance would strike from the rider's left. It has been proposed that Federico's opponent's wooden lance splintered on impact, perhaps inadvertently lifting the Duke's helmet visor and exposing the eye to injury.[1] According to most historical accounts, Federico's nose was injured simultaneously, suggesting that the lance first struck the bridge of the nose, then the right eye.

However, some have taught that the Duke subsequently underwent nasal surgery in an attempt to compensate for the loss of his right eye. For example, the plastic surgeons Gillies and Millard wrote, "There was the one-eyed Duke of Montifeltre [sic], who had a portion of his nasal bridge removed to increase his field of vision."[2] Similarly, a popular lecture series on the Italian Renaissance stated, "Early in his career, he was blinded in one eye during a tournament and, afraid that he would not have full use of his field of vision as a consequence, he had the cartilage removed from his nose."[3]

The medical care in Urbino during the 15th century was relatively advanced, and it has been suggested that surgery of this type could have been performed.[4] Would the surgery have improved his visual function? There are at least three possible mechanisms: expansion of the nasal visual field, reduction of ocular parallax in adduction, and shifting of the visual egocenter.

Expansion of the Nasal Visual Field

The physiologic nasal visual field is known to be smaller than the temporal visual field in primary gaze, but what if the eye

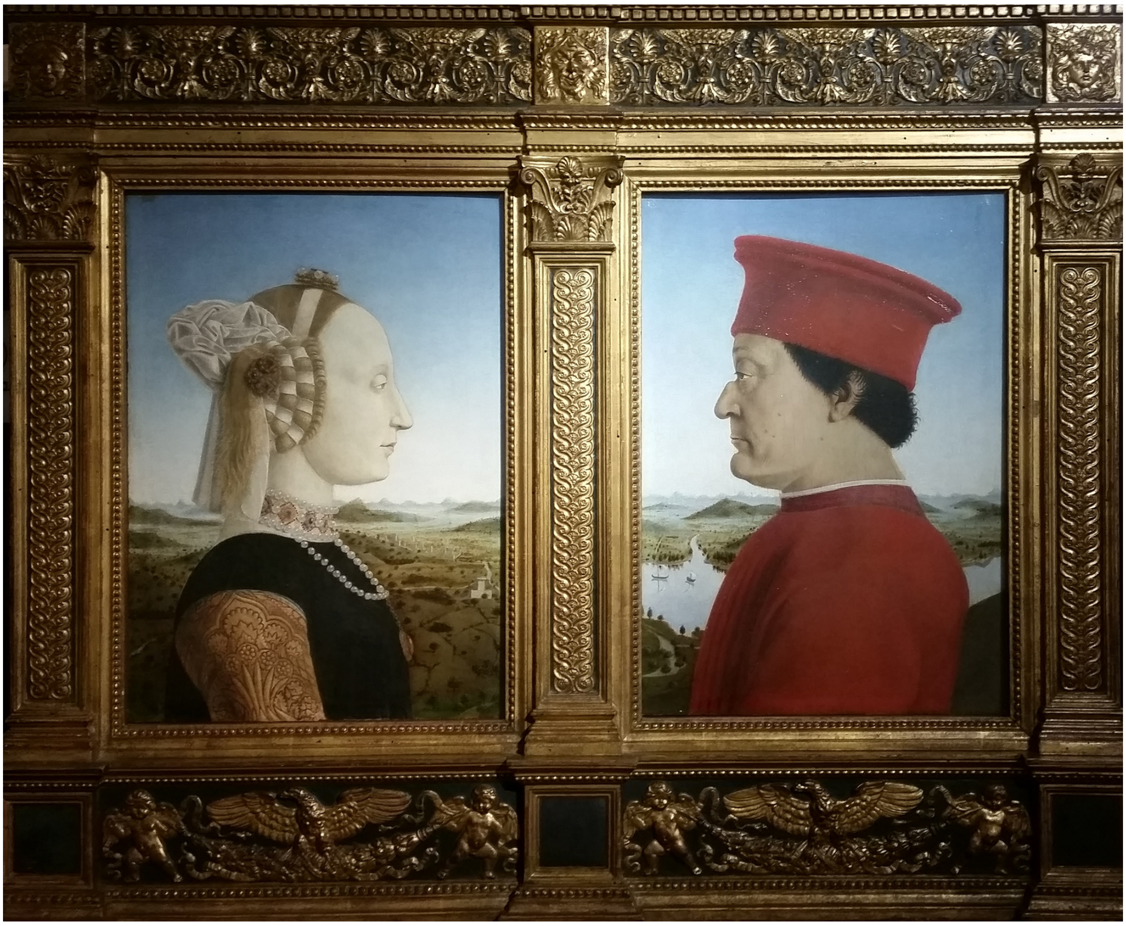

Figure 1. Piero della Francesca, *Portraits of the Duke and Duchess of Urbino*. Note the nasal deformity of the Duke. Photograph taken by the author (SGS).

is turned in abduction? Glaser[5] evaluated Goldmann visual fields in primary gaze and with abduction of the tested eye using a head turn. He studied a multiracial cohort of 10 normal volunteers and concluded that the maximum extent of the nasal field was 64°; this was regardless of the size or shape of the nose. He then suggested that physiologic nasal field constriction is “apparently due to asymmetry of retinal topography and sensitivity”. Hence, normative data for adults have been described, but current studies suggest that the peripheral visual field in children continues to expand from infancy until about 11 years of age, at which time it mirrors the adult visual field.

Severe restriction of the infant visual field is reported, regardless of the target method (flickering lights or gratings to solid objects). The infant visual field expands over 2–3 years during early childhood.[6,7] Even somewhat older children continue to demonstrate lower peripheral sensitivity according to some authors; different methodological techniques, as well as evolving cognitive and attentional abilities, may convey variable responses in testing.[8] Truly, any clinician will attest to the effect of attentional ability on performance and visual field sensitivity. Adult attentional ability can be linked to expectation of an object appearing in the visual field, which enhances visual performance. The Duke’s watchful attention span may have helped his visual field performance but his age (19 years old at the time of injury) would mitigate against any substantive change in visual field area.

However, there are also detectable interpatient differences in the extent and shape of the nasal visual field; the precise reasons are unknown, but some variable factors affecting it have been described.[9] View obstruction can occur in the nasal or temporal visual field. The eyebrow arches superiorly and the nose nasally, which can be associated with some changes that appear to fall within reproducibility.[10] Phan et al.[11] evaluated Humphrey visual fields (30-2 and 60-4 programs, in primary gaze and with abduction of the tested eye) in 43 subjects, including normal volunteers and glaucoma patients. They reported that abduction of the eye results in a significantly increased sensitivity in four points along the inferonasal border of the 60-4 field, which measures as 60° from fixation. An example of this phenomenon is illustrated in Figure 2.

In the context of the Duke’s visual goals, eye motion visual fields become an important consideration. It is called “maximum field of vision” and is defined as allowing eye movement to expand the field of vision or eye movement visual field (EMVF) as compared to binocular visual field (BVF),

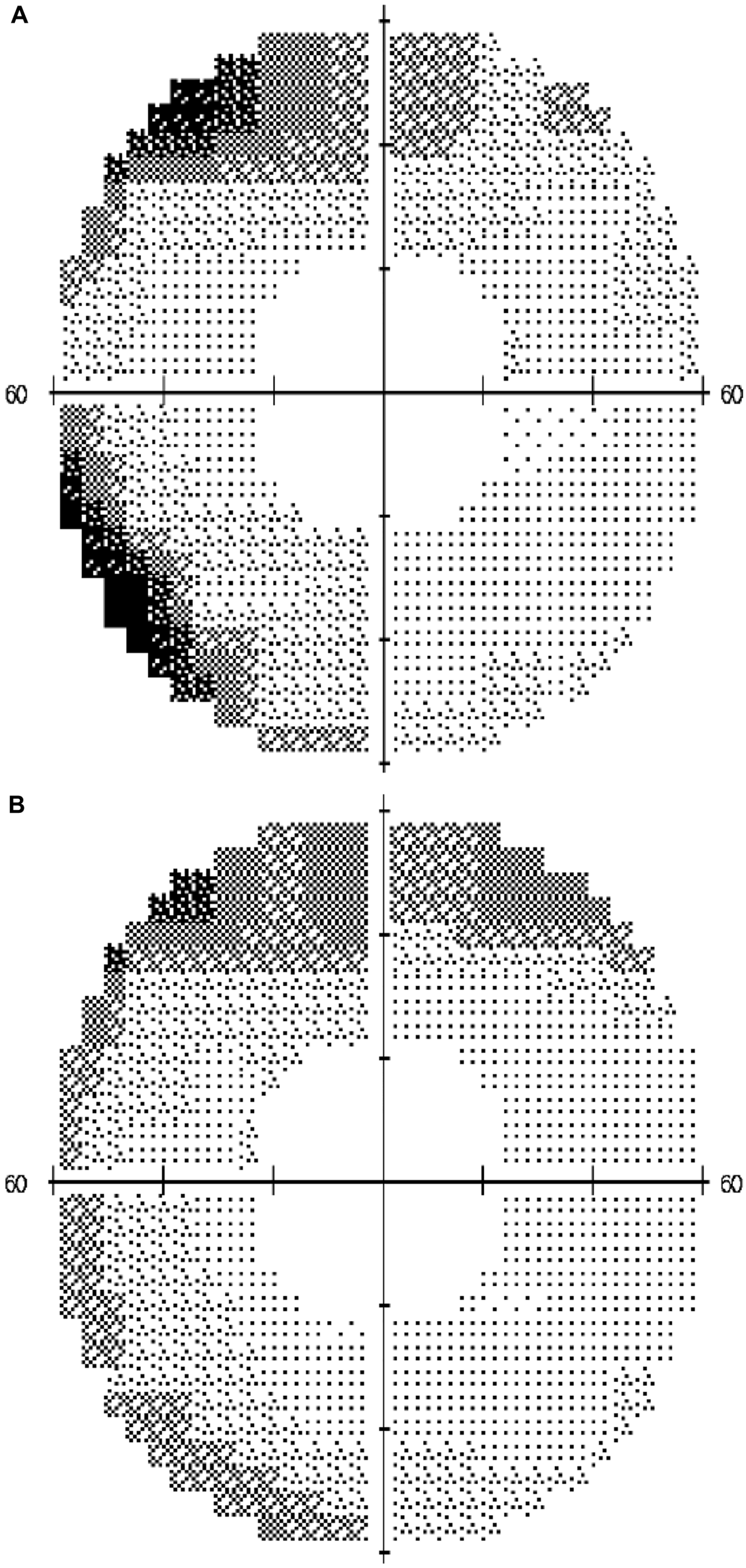

Figure 2. (**A**) Humphrey visual field, right eye, using the 60-4 testing program. Note the field restriction superonasally and inferonasally. (**B**) Humphrey visual field, right eye, using the 60-4 testing program on the same patient, but with a nasal head turn of 30°, resulting in abduction of the right eye. The superonasal field cut persists, but the inferonasal field cut appears improved. This figure was obtained for the purpose of this review and is not of one of the patients reported in the study by Phan et al.[11]

which does not allow eye movement. The EMVF is reported to increase the temporal visual field by 37% and is thought to be an adaptation to allow the biped to see more peripherally with less head turning.[10] Corresponding studies for the nasal field have not been reported, but the nose may act analogous to thick temporal frames and wide solid eyeglass arms. It has been reported that the EVMF surface area can be affected by thick eyeglass frames when they are compared to thin eyeglass frames (or no eyeglass frames). While the thin frames encompass a visual field area that is similar to the normal, the thicker frames decrease "temporal visual field exploration" as they achieve their purpose of lateral glare reduction. The thick frames do not affect the BVF.[12]

Reduction of Ocular Parallax

Reduction of ocular parallax may provide some additional benefit in adduction. Ocular parallax, first described by Brewster in 1844,[13] describes a situation in which movement of the eye causes objects to disappear from or reappear into view. To illustrate this concept, the reader is asked to perform the following steps:

1. Close the left eye;
2. Direct the right eye straight ahead (primary gaze);
3. Extend the left arm slightly (not all the way forward);
4. Extend the left thumb in a *thumb's up* position;
5. Position the left thumb so that it is just visible in the far peripheral nasal (left) visual field of the right eye;
6. Keeping the left eye closed and the left thumb stationary, quickly turn the right eye to the left (adduct) in order to fixate on the left thumb. The left thumb will disappear from view, blocked by the nose; and
7. Keeping the left eye closed and the right eye adducted, extend the left arm so that the thumb moves forward (away from the body). The left thumb will reappear into view.

Mapp and Ono[14] described this as the rhino-optical phenomenon, explained by the fact that the nodal point of the eye (where rays of light converge) is in a different position from (slightly anterior to) the center of rotation of the eye.

Shifting of the Visual Egocenter

It has been suggested that binocular individuals judge the directions of targets from a single point midway between the two eyes, referred to as the visual egocenter or cyclopean eye.[15,16] Following the loss of one eye, the egocenter has been reported to migrate toward the remaining eye in certain circumstances.

For example, Moidell et al.[17] used psychophysical testing on two groups of subjects (aged 5–29 years) as follows: one group had a history of monocular retinoblastoma and enucleation prior to 4 years of age and the second (control) group contained normal age-matched binocular individuals with the corresponding eye patched. The subjects were asked to fixate upon a toy firefighter with a hose that extended from the toy toward the subject so that the hose aimed at the subject's eye's visual axis. The subjects were then asked to rotate a lever (positioned under the toy) so that the lever positioned along the axis of the hose. The control subjects tended to align the lever along the median plane of the head (the egocenter), but the enucleated subjects tended to align the lever so that it was about three-fourths of the distance toward the remaining eye, demonstrating a shift of the egocenter.

Discussion

Did the Duke undergo nasal surgery in order to compensate for the loss of his right eye? This widely taught story cannot be proven, and many medical historians doubt its veracity.[18] Regardless of whether or not the surgery was actually performed, would it have been beneficial, beyond a placebo effect? Federico was 19 years old at the time of the injury, so his visual field had long reached its maximum extent. It is interesting, but purely speculative, to suggest that removing part of the Duke's nasal bridge might have allowed an expansion of the EMVF, perhaps analogous to shifting from thicker sunglasses to thinner sunglasses in the experiments described above. If this is correct, then some improvement might be expected. It may be helpful to consider animal species with laterally placed eyes, such as turtles or rabbits, in which obstruction by the anterior facial structures limits or prevents stereopsis.[19]

Van Tonder et al.[20] proposed that both the reduction of ocular parallax and the shifting of the visual egocenter would have been beneficial. This hypothesis seems plausible, although some questions remain unanswerable without direct evidence or available experimental data. Ocular parallax, at least as described above, appears to occur only under relatively artificial testing conditions and without head rotation, so the associated real-world benefits are difficult to estimate. Further, shifting of the visual egocenter is interesting, but it is uncertain how the nasal surgery might have affected this phenomenon.

History contains many examples of warriors who enjoyed celebrated military careers, despite losing an eye. These include the Japanese samurai Date Masamune (1567–1636)[20] and perhaps the British naval commander Horatio Nelson (1758–1805), although some have disputed the latter.[21,22] We are not aware of any other monocular warriors who underwent compensatory nasal surgery, which suggests that such an intervention does not provide a major benefit.

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Author Contributions

Conceived and designed the review: SGS. Analyzed the data: SGS, CTL, PSC. Wrote the first draft of the manuscript: SGS.

Contributed to the writing of the manuscript: CTL, PSC, FK, DB, HWF. Agreed with manuscript results and conclusions: SGS, CTL, PSC, FK, DB, HWF. Jointly developed the structure and arguments for the paper: SGS, CTL, PSC. Made critical revisions and approved the final manuscript: SGS, CTL, PSC, FK, DB, HWF. All the authors reviewed and approved the final manuscript.

REFERENCES

1. Winters HPJ. Federico da Montefeltro, Duke of Urbino (1422-1482): the story of his missing nasal bridge. *Br J Plast Surg*. 1982;35(3):247–50.
2. Gillies H, Millard DR. *The Principles and Art of Plastic Surgery*. Boston, MA: Little, Brown and Company; 1957:14.
3. Bartlett KR. Urbino [lecture]. *Italian Renaissance*. Chantilly, VA: The Great Courses; 2005. Course #3970.
4. Santoni-Rugiu P, Massei A. The legend and the truth about the nose of Federico, Duke of Urbino. *Br J Plast Surg*. 1982;35(3):251–7.
5. Glaser JS. The nasal visual field. *Arch Ophthalmol*. 1967;77(3):358–60.
6. Dobson V, Brown AM, Harvey EM, Narter DB. Visual field extent in children 3.5–30 months of age tested with a double-arc LED perimeter. *Vision Res*. 1998;38(18):2743–60.
7. Tschopp C, Safran AB, Viviani P, Reicherts M, Bullinger A, Mermoud C. Automated visual field examination in children aged 5–8 years. Part II: normative values. *Vision Res*. 1998;39(14):2211–8.
8. Tschopp C, Visiani P, Reicherts M, et al. Does visual sensitivity improve between 5 and 8 years? A study of automated visual field examination. *Vision Res*. 1999;39(6):1107–19.
9. Swanson WH, Dul MW, Horner DG, Malinovsky VE. Individual differences in the shape of the nasal visual field. *Vision Res.* 2016 Jun 16. pii: S0042-6989(16)30009-8. doi: 10.1016/j.visres.2016.04.001. [Epub ahead of print].
10. Denion E, Dugue AE, Coffin-Pichonnet S, Augy S, Mouriaux F. Eye motion increases temporal visual field extent. *Acta Ophthalmol*. 2014;92(3):e200–6.
11. Phan L, Leffler CT, Allen RC, Schwartz SG, Karandikar AP. Effect of turning the head nasally on the visual field. *ARVO Abstr*. 2004;45:3299.
12. Denion E, Dugue AE, Augy S, Coffin-Pichonnet S, Mouriaux F. Sunglasses with thick temples and frame constrict temporal visual field. *Optom Vis Sci*. 2013;90(12):1450–5.
13. Brewster D. On the law of visible position in single and binocular vision and on the representation of solid figures by the union of dissimilar plane pictures on the retina. *Trans R Soc Edinburgh*. 1844;15:349–68.
14. Mapp AP, Ono H. The rhino-optical phenomenon: ocular parallax and the visible field beyond the nose. *Vision Res*. 1986;26(7):1163–5.
15. Ono H. Axiomatic summary and deductions from Hering's principles of visual direction. *Percept Psychophys*. 1979;25(6):473–7.
16. Barbeito R, Ono H. Four methods of locating the egocenter: a comparison of their predictive validities and reliabilities. *Behav Res Methods Instrum*. 1979;11(1):31–6.
17. Moidell B, Steinbach MJ, Ono H. Egocenter location in children enucleated at an early age. *Invest Ophthalmol Vis Sci*. 1988;29(8):1348–51.
18. Gonzalez Martin-Moro J, Gonzalez Martin-Moro J, Azurza Rivas G. La bizarre historia del duque de Urbino. Cirugia nasal para mejorar el campo visual? [The bizarre history of the Duke of Urbino. Nasal surgery to improve visual field?]. *Arch Soc Esp Oftalmol*. 2010;85(1):47–50.
19. Gao Z, Wang P, Zhai R, Tang Y. Frontally placed eyes versus laterally placed eyes: computational comparison of their functions for ego-motion estimation. *J Opt Soc Am A Opt Image Sci Vis*. 2016;33(4):501–7.
20. Van Tonder G, Zavagno D, Sakurai K, Ono H. Seeing further than your nose. *Perception*. 2013;42(5):481–7.
21. Wilson G. Horatio Nelson: the one-eyed Admiral? *Clin Exp Ophthalmol*. 2005;33(5):516–7.
22. Barras TC. Vice-Admiral Nelson's lost eye. *Trans Ophthalmol Soc U K*. 1986;105(t 3):351–5.