Art exists because the viewer exists: how François Morellet's Triple X Neonly influences postural control and subjective aesthetic appreciation

Lindsey M Ward, Aurélien Morize, Marine Vernet, Chrystalina Antoniades, Zoï Kapoula

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GENERAL NOTE

Art Exists Because the Viewer Exists

How François Morellet's Triple X Neonly *Influences Postural Control and Subjective Aesthetic Appreciation*

LINDSEY M. WARD, AURÉLIEN MORIZE, MARINE VERNET, CHRYSTALINA ANTONIADES AND **ZOÏ KAPOULA**

ABSTRACT

The authors study the effects of viewing François Morellet's *Triple X Neonly* (2012) on postural control and subjective appreciation. Participants were asked to view monocularly and binocularly. Their average forward-backward (anteroposterior) body sway root mean square (rms) velocity was significantly greater viewing it monocularly. Participants showed diverse reactions to the artwork, yet comments mainly concerned apparent movement and depth. The authors conclude that binocular viewing facilitates viewer appreciation of the proximity of the central X, thus requiring less energy to keep the body stable. This study confirms the artist's success in involving viewers actively in their aesthetic experience through their eye and body movements.

BACKGROUND

François Morellet is a French conceptual artist known for creating abstract, geometric light sculptures that play with the viewer's perception. His work *Triple X Neonly* was shown at the *Dynamo* exhibition at the Grand Palais in Paris in 2013 [1].

The exhibition centered around how artists explored the intersection between light, space, movement and vision, often incorporating the point of view of the observer into the aesthetic experience. *Triple X Neonly*, in particular, provides a unique opportunity to explore the effects of binocular and monocular viewing and depth perception on a viewer. The artwork was situated in a corner of the exhibit and consisted of six neon tubes arranged into a triple X pattern. The two lateral X's were arranged along each side of the wall, while the central X was attached to each wall and protruded out into space. This projection into space created the illusion of the central X oscillating between appearing in a flat plane with the other two X's and projecting out into space toward the viewer. Our study aimed to understand how this illusion of oscillation in depth created a physiologic response in the viewer.

Morellet was one of the founding members of the Groupe de recherche d'art visuel (GRAV), an artist collective that sought to create art based on the relationship between the art object and the viewer's eye [2]. Instead of standing alone, bestowed by an autonomous artist to be beheld by the spectator, the artwork is unstable, open and ever-changing, dependent on a feedback system between object and viewer that is complex and dynamic [3]. This fluid, oscillating relationship mirrors the physiology of the viewer: The eyes are always moving around the piece, creating single perceptions of a piece that layer over time on each other to produce an overall effect on the viewer.

To understand how the piece manipulates the viewer's posture and vision, it is important to understand the complex system of binocular viewing created, in part, by vergence and accommodation. Normally, vergence allows the viewer to adjust the angle of optic axes according to the distance or depth of the object of interest they are observing. For near objects, the eyes move toward each other to increase the vergence angle. For objects that are farther away, the eye moves in opposite directions to decrease the vergence angle. Eye accommodation, a monocular cue, and disparity, a binocular cue, are two cues driving vergence [4–6]. Thus, vergence eye movements foveate the object of interest simultaneously in each eye, thereby leading to a single, fused binocular vision. It has also been shown that depth perception, i.e. judgment of distance between objects, is more accurate when vergence eye movements occur rather than when gaze is fixed [7].

How might the perception of depth in *Triple X Neonly* affect the viewer's posture? When objects are placed more proximally to a viewer, the viewer is more stable and there-

Lindsey M. Ward (physician, researcher), IRIS team, Physiopathologie de la Vision et Motricité Binoculaire, FR2022 Neurosciences CNRS, Université de Paris, 45 rue des Saints-Pères, 75006, Paris, France. Email: Lward@mednet.ucla.edu.

Aurélien Morize (researcher), IRIS team, Physiopathologie de la Vision et Motricité Binoculaire, FR2022 Neurosciences CNRS, Université de Paris, 45 rue des Saints-Pères, 75006, Paris, France. Email: Aurelien.morize@gmail.com.

Marine Vernet (CNRS Researcher), IRIS team, Physiopathologie de la Vision et Motricité Binoculaire, FR2022 Neurosciences CNRS, Université de Paris, 45 rue des Saints-Pères, 75006, Paris, France; IMPACT team, Lyon Neuroscience Research Center (CRNL), CNRS UMR 5292, INSERM UMRS 1028, University Claude Bernard Lyon 1, Lyon, France. Email: marine.vernet@gmail.com.

Chrystalina Antoniades (educator), The NeuroMetrology Lab, Nuffield Department of Clinical Neurosciences, University of Oxford, Oxford, OX3 9DU, U.K. Email: chrystalina.antoniades@ndcn.ox.ac.uk.

Zoï Kapoula (research administrator), IRIS team, Physiopathologie de la Vision et Motricité Binoculaire, FR2022 Neurosciences CNRS, Université de Paris, 45 rue des Saints-Pères, 75006, Paris, France. Email: zoi.kapoula@gmail.com.

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fore moves less [8–11]. Conversely, when a viewer perceives an object as being farther away, they are less stable [12]. This depth effect has also been demonstrated with pictured depth in paintings during binocular viewing. In one such study, when participants observed paintings with a powerful representation of perspective, they had higher body sway when focusing on the recessed space than when focusing on the foreground of the painting [13].

To measure the effect of such perceived depth in the *Triple X Neonly* artwork on a viewer, we examined the impact of the work on the viewer with two conditions: (a) monocular and (b) binocular viewing. During these two conditions, physiologic measurements of stability and energy used to control posture were measured. Immediately after, the observer's subjective experience (ratings of appreciation, destabilization and free text commentary) were recorded. We had three aims in mind: first, to determine if any postural parameter was impacted by the artwork; second, if there was a difference between monocular and binocular viewing; and third, if this impact was related to subjective reports by the observer.

We hypothesized that binocular viewing would allow the viewers to see the central X projected into space, while with monocular vision they would only perceive the central X as recessed into the same far plane as the lateral Xs. In monocular viewing, as the viewer does not perceive the depth of the work, the body will become more unstable as the eye places the central X in a plane that is farther away from the body. In contrast, in the binocular condition, via binocular disparity, the viewer perceives the object as projecting forward in space, closer to the body, and therefore will be more stable.

DISCUSSION

This study examined postural parameters when participants observed Morellet's *Triple X Neonly* with their dominant eye (monocular) versus with both eyes (binocular). Observers demonstrated a higher forward-backward velocity with monocular viewing than with binocular viewing, i.e. participants swayed with higher speed in the forward-backward directions in monocular viewing than in binocular viewing. As forward-backward velocity is associated with the amount of energy required to keep the body stable while holding posture, participants required more energy to keep them stable during monocular viewing than binocular viewing [14]. Due to the lack of binocular disparity, with one eye open, it is more difficult to appreciate the proximity of the central X in space; it appears as if it is in a single plane, with the others receding along the wall. Therefore, in the monocular condition, the central X appears farther than in the binocular condition. As stability has been shown to be correlated with distance of an object from the viewer, the binocular condition was more stable [15].

In addition to the posturographic differences between the two conditions, it is important to consider the subjective comments of the observers. The group had a wide range of appreciation for the artwork, ranging from 2.4 to 10 (0: no appreciation, 10: highest appreciation). It is notable that of the 16 comments, 11 spontaneously referenced movement (five participants) or depth (six participants). For example, in the monocular condition, one participant reported the work was "flat, 2D, a little 3D effect. With both eyes, huge 3D effect and it was only after I realized it was really 3D" [16]. It is striking that the majority of these comments reference depth or movement, which mirrors our hypothesis that binocular vision in the observer enhances depth perception; the body senses this depth perception and moves according to the perceived proximity of the central X. It is remarkable that most viewers, by referencing depth and movement, were conscious of this effect and were in tune with the movement of their body.

This study is one of the few studies performed to date, to our knowledge, that can examine the artist's intended effect on the observer. Although it is nearly impossible to discover an artist's intention, in contemporary art, interviews and writings by the artist can help make the intended meaning of the work clearer. Morellet himself agrees it can be difficult to find an artist's meaning in their work, writing, "Works of fine art have never succeeded in transmitting to the observer the message, the philosophy, poetry, or even sensibility which the artist intended" [17]. For Morellet, it is extremely difficult for the artwork itself to impose a meaning onto the viewer when the work is separated from the observer. Instead, by creating art, he makes "useless (consequently artistic) objects . . . simple and obvious systems, frequently concerned with pure chance or the participation of the viewer" [18]. His works take the viewer into account and minimize the artist's intervention, so that "everything you find, apart from [the artist's] small systems . . . belongs to you as observer" [19]. Therefore, for Morellet, without the viewer's interaction, the work of art remains incomplete, and the observer plays an integral part in the success of the piece of art.

Our findings reflect the larger philosophy of GRAV. While these artists strove to manipulate the perceptual systems of their viewers through their artwork, creating an aesthetic field dependent on time and space, there have been few studies that have quantified the physiologic effect of the field on the viewer. Indeed, as the artist group hypothesized, the unstable binocular viewing system creates a flickering in perception between two and three dimensions, perpetuated throughout the body through an induced unstable oscillation in the viewer.

This is particularly poignant with regard to *Triple X Neonly*. Through their visual system, the viewer fulfills the complexity of the piece, the flickering of the central X between distal (monocular viewing) and proximal (binocular viewing). Thus, the artwork does not exist without the viewer. In analyzing both the subjective comments and objective posturographic measurements, it is clear the observers understood the manipulation of the piece. Many observers spontaneously commented on the creation of movement or depth, and the work succeeded in modulating the viewer's body sway as their participation in the illusion manipulated their perception and their body. It is important to note that our experiment explores the two extremes of monocular and binocular vision. As a casual viewer, one may not think to observe the work with only monocular vision. However, as

the eyes explore the piece, there are times when the two eyes are not completely coordinated, disrupting binocular vision, in an effect akin to the monocular condition, causing the central X to oscillate in space. Therefore, as the perceived artwork's depth oscillates, forcing the observer to move, one could consider the work to be complete.

It is curious that Morellet created this piece in 2012, long after the height of the GRAV movement. By creating art that inherently relied on human perception, GRAV considered their art to be egalitarian; the visual system that permits the aesthetic field to come into existence is universal [20]. In the 21st century, a time in which the cult of the artist seems more inflated than ever, and in which art feels more removed from the populace than ever, it matters that Morellet provides a reminder that the artwork resides nowhere else but intrinsically with the viewer who beholds it.

References and Notes

1 Galerie m, *François Morellet*: www.galerie-m.com/artist_image_en.php?&aid=31&aname=Fran%C3%A7oisMorellet (accessed 15 October 2021).

2 C. Bishop, *Artificial Hells: Participatory Art and the Politics of Spectatorship* (Verso Books, 2012) pp. 87–93.

3 A. Alberro, *Abstraction in Reverse: The Reconfigured Spectator in Mid-Twentieth-Century Latin American Art* (University of Chicago Press, 2017) pp. 130–150.

4 G.S. Masson, C. Busettini and F.A. Miles, "Vergence Eye Movements in Response to Binocular Disparity without Depth Perception," *Nature* **389** (1997) pp. 283–286: doi:10.1038/38496.

5 C. Rashbass and G. Westheimer, "Disjunctive Eye Movements," *Journal of Physiology* **159** (1961) pp. 339–360.

6 G.F. Poggio and B. Fischer, "Binocular Interaction and Depth Sensitivity in Striate and Prestriate Cortex of Behaving Rhesus Monkey," *Journal of Neurophysiology* **40** (1977) pp. 1392–1405: doi:10.1152/jn.1977.40.6.1392.

7 I.P. Howard, *Seeing in Depth,* Vol. 2 (Oxford Univ. Press, 2008).

8 O. Aoki et al., "Influence of Gaze Distance and Downward Gazing on Postural Sway in Hemiplegic Stroke Patients," *Experimental Brain Research* **232** (2014) pp. 535–543: doi:10.1007/s00221-013-3762-3.

9 J. Munafo et al., "The Distance of Visual Targets Affects the Spatial Magnitude and Multifractal Scaling of Standing Body Sway in Younger and Older Adults," *Experimental Brain Research* **234** (2016) pp. 2721–2730. doi:10.1007/s00221-016-4676-7.

10 W.M. Paulus, A. Straube and T. Brandt, "Visual Stabilization of Posture. Physiological Stimulus Characteristics and Clinical Aspects," *Brain* **107**, No. 4, 1143–1163 (1984).

11 W. Paulus et al., "Differential Effects of Retinal Target Displacement, Changing Size and Changing Disparity in the Control of Anterior/Posterior and Lateral Body Sway," *Experimental Brain Research* **78** (1989) pp. 243–252.

12 Aoki et al. [8]; Munafo et al. [9]; Paulus, Straube and Brandt [10].

13 Z. Kapoula et al., "Pictorial Depth Increases Body Sway," *Psychology of Aesthetics, Creativity, and the Arts* **5** (2011) pp. 186–193.

14 M. Vernet and A. Morize and Z. Kapoula, "Postural and Emotional Impact of Carsten Höller's Artwork 'Light Corner,'" in Zoï Kapoula et al., eds., *Exploring Transdisciplinarity in Art and Sciences* (Cham, Switzerland: Springer, 2018).

15 Aoki et al. [8]; Munafo et al. [9]; Paulus, Straube and Brandt [10].

16 See Table 2, online supplemental material.

17 F. Morellet, www.m-bochum.de/artist_info_en.php?SID=ef7OojR2weoE&aid=31&aname=Fran%E7oisMorellet (1972) (accessed 15 October 2021).

18 Morellet [17].

19 Morellet [17].

20 Alberro [3].

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LINDSEY WARD *is a resident physician in Internal Medicine at the University of California, Los Angeles and a PhD candidate at the Université de Paris. Her research is at the intersection of art and science, focusing on how we experience art and how that knowledge can benefit the medical field.*

AURÉLIEN MORIZE *is a researcher who studies optics and optometry in the IRIS lab. His research focuses on eye movements.*

MARINE VERNET *is a CNRS researcher in cognitive neuroscience. Her work focuses on human consciousness during perception, thoughts and action, using a combination of neuroimaging and neurophysiological and behavioral experiments.*

CHRYSTALINA ANTONIADES *is an A/Professor in the Nuffield Department of Clinical Neurosciences in Clinical Neurology at the University of Oxford and the John Radcliffe Hospital. Her work focuses on movement disorders such as Parkinson's disease and their quantification using cutting-edge digital technology.*

ZOÏ KAPOULA, *PhD./HDR, EMBA, Research Director at the CNRS, in the field of cognitive neurosciences, is leader of the IRIS CNRS lab specialized in the neuro-physiopathology of eye movements: their interaction with vision, perception, cognition, body equilibrium, and posture. Works on dyslexia, strabismus, tinnitus, vestibular deficits, vertigo, aging, cognitive impairment and dementia in humans. She teaches eye movement control in neuroscience masters, orthoptics and optometry. She patented the REMOBI & AIDEAL technologies and founded the Orasis-Ear (orasis-ear.com) spinoff of the CNRS to bring innovations to health professionals. She created a national network on art and neurosciences and a school on transdisciplinarity and has published books on the subject.*

Art Exists Because the Viewer Exists: How François Morellet's *Triple X Neonly* influences postural control and subjective aesthetic appreciation

Lindsey M Ward[1], Aurélien Morize[1], Marine Vernet[1,2], Chrystalina Antoniades[3], Zoï Kapoula[1,*]

1 IRIS team, Physiopathologie de la Vision et Motricité Binoculaire, FR2022 Neurosciences CNRS, Université de Paris, 45 rue des Saints-Pères, 75006, Paris, France.

2 IMPACT team, Lyon Neuroscience Research Center (CRNL), CNRS UMR 5292, INSERM UMRS 1028, University Claude Bernard Lyon 1, Lyon, France.

3 The NeuroMetrology Lab, Nuffield Department of Clinical Neurosciences, University of Oxford, Oxford, OX3 9DU, United Kingdom.

*** Correspondence:**
Corresponding author: Zoï Kapoula; 45 Rue des Saints Pères, Paris, France 75006; Phone: +33 (0)1 42 86 33 23; zoi.kapoula@gmail.com

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Abstract

We studied the effects of viewing François Morellet's *Triple X Neonly* (2012) on postural control and subjective appreciation. *Triple X* consists of 6 neon tubes arranged in a corner into a triple X pattern. Twenty-one participants were asked to view it with only one eye open (monocularly) and with both eyes open (binocularly). Their average forward-backward (anteroposterior) body sway root mean square (rms) velocity was significantly greater viewing it monocularly than binocularly. There were also large differences between subjects during monocular viewing for three of the six measured postural parameters (rms side-to-side (mediolateral) velocity, rms side-to-side displacement, and rms normalized area of the movement of the locus of centre of gravity). The participants showed very diverse subjective reactions to the artwork, yet their comments mainly concerned its apparent movement and depth. We conclude that binocular viewing allows the viewer more easily to appreciate the proximity of the central X, thus requiring less energy to keep the body stable. This study confirms the artist's success in involving viewers actively in their aesthetic experience: through their eye and body movements, the work engages them to actively contribute to the work itself.

1 Introduction

François Morellet is a French Conceptual artist known for creating abstract, geometric light sculptures that manipulate the viewer's perception. Morellet's work, *Triple X Neonly*, was shown at the "Dynamo" exhibition at the Grand Palais in Paris, France in 2013. (goo.gl/EGERH3) The exhibition centered around how artists explored the intersection between light, space, movement, and vision, often incorporating the point of view of the observer into the aesthetic experience. *Triple X Neonly*, in particular, provides a unique opportunity to explore the effects of binocular and monocular viewing and depth perception on a viewer. The artwork was situated in a corner of the exhibit and consisted of 6 neon tubes arranged into a triple X pattern. The two lateral X's were arranged along each side of the wall, while the central X was attached to each wall and protruded out into space. This

projection into space created the illusion of the central X oscillating between appearing in a flat plane with the other two X's and projecting out into space towards the viewer. Our study aimed to understand how this illusion of oscillation in depth created a physiologic response in the viewer.

Morellet was one of the founding members of the Groupe de recherche d'art visuel (GRAV), an artist collective that sought to create a type of art based on research on the relationship between the art object and the viewer's eye.[1] The group sought to reject the concept that an artwork was defined as the object presented in front of the viewer. Instead of standing alone, bestowed by an autonomous artist to be beheld the spectator, the artwork is unstable, open, and ever changing, fundamentally dependent on its relationship with the spectator, representing a feedback system between object and viewer that is complex and dynamic.[2] This fluid, oscillating relationship mirrors the way the physiologic way the viewer perceives the artwork. The eyes are always moving around the piece, creating single perceptions of a piece that layer over time on each other to produce an overall effect on the viewer.

This collapse in distance between viewer and art object prompted artists to manipulate time and space in order to make the viewer cognizant of how they physiologically interact with the artwork. Fundamental to provoking this realization in the viewer is the concept of instability. By inducing movement, the spectator's experience in the field of the artwork becomes complex.[3] By creating movement in the piece, the viewer is forced to understand that her relationship with the piece is temporal. By creating pieces with multiple focal points, or multiple ways of seeing, the viewer is forced to recognize the piece actually exists as a whole only in the layering of fragmented pieces of perception that stretch across position and time. As the relationship changes as a result of movement and time, the artwork becomes fundamentally unstable and becomes complete in the relationship, or in the aesthetic field, created between viewer and object.[2]

The instability provoked by the addition of movement in light in these artworks is mirrored by the mechanism by which it manipulates the viewer: the optical instability of the retina. The artwork seeks to provoke and exacerbate the instability of the physiologic mechanisms of perception. In this case, Morellet chose to manipulate the instability of binocular viewing by creating a light sculpture that has an ambiguous depth component. By using light, which moves towards the viewer's retina at a certain frequency, Morellet creates a fundamentally dynamic piece. Even further, by arranging the light sculpture in this very intentional way, Morellet makes the three-dimensionality of the piece ambiguous, allowing the eye, through binocular vision, to perceive the piece from different perspectives (two and three-dimensional) even while standing still.

To understand how the piece manipulates the viewer's posture and vision, it is important to understand the complex system of binocular viewing created, in part, by vergence and accommodation. Normally, vergence allows the viewer to adjust the angle of optic axes according to the distance or depth of the object of interest she or he is observing. For near objects, the eyes move towards each other to increase the vergence angle. For objects that are farther away, the eye moves in opposite directions to decrease the vergence angle. Eye accommodation, a monocular cue, and disparity, a binocular cue, are two important cues driving vergence. [4-6] Thus, vergence eye movements foveate the object of interest simultaneously in each eye, thereby leading to single, fused binocular vision. It has also been shown that depth perception, i.e. judgment of distance between objects, is more accurate when vergence eye movements are allowed rather than when the gaze is fixed.[7]

How might the perception of depth in *Triple X Neonly* affect the viewer's posture? When objects are placed more proximally to a viewer, the viewer is more stable and therefore moves less. [8-11] Conversely, when a viewer perceives an object as being farther away, she or he is less stable. [8-11] This depth effect has been previously demonstrated with pictured depth in paintings during binocular viewing. In one such study, when participants observed paintings with a powerful representation of perspective, they had higher body sway when focusing on the recessed space than when focusing on the foreground of the painting.[12]

In order to quantify this physiologic response, posturography has recently been used in the field of neuroaesthetics as a tool to measure the viewer's direct physiologic response to an artwork. [13] Posturography allows researchers to quantify postural control in a quick and noninvasive manner to provide valuable information regarding the integration of visual, vestibular, cutaneous, and muscle proprioceptive information by the nervous system. One can then, in turn, measure the muscular responses to these stimuli by recording the action of a feedback control system [14]. For example, body sway has traditionally been believed to be controlled by two separate muscular strategies. The first, located at the ankle, is described by anteroposterior, or forward-backward, body sway. The second, located at the hip, is described by mediolateral, or side-to-side, body sway. [15] [16, 17] [18]

Because depth perception relies on binocular disparity, which requires binocular vision, it was useful to assess viewer's response to the artwork with both monocular and binocular viewing. To measure the effect of the perceived depth in the *Triple X Neonly* artwork, we thus examined the impact of the work on a viewer with two conditions (a) a monocular and (b) a binocular viewing. During these two conditions, physiologic measurements of stability and energy used to control posture were measured. Immediately after, the observer's subjective experience (ratings of appreciation, destabilization, and free text commentary) were recorded. We had three aims in mind. First, to determine if any postural parameter was impacted by the artwork, second, if there was a difference between monocular and binocular viewing, and third, if this impact was related to subjective reports by the observer.

We hypothesized that binocular viewing will allow the viewers to see the central X projected into space, while with monocular vision they will only perceive the central X as recessed into the same far plane as the lateral X's. In monocular viewing, as the viewer does not perceive the depth of the work, the body will become more unstable as the eye places the central X in a plane that is farther away from the body. In contrast, in the binocular condition, via binocular disparity, the viewer perceives the object as projecting forward in space, closer to the body, and therefore will be more stable.

2 Materials and Method

2.1 The Artwork

François Morellet's *Triple X Neonly* is an installation of 6 tubes filled with blue argon arranged in a triple X pattern. The artwork is formed by two walls that create a corner. Along each wall lie two tubes that form an X. In the center of the piece, two tubes attach to each wall and create an X that projects into space across the corner. Each of the side X's are 5 meters wide and 3.3 meters tall. Each observer was placed in the middle of the room at 3 meters from the corner of the wall, and 1.4 meters from the central X, creating a visual angle of at least 122 degrees horizontally and 99 degrees vertically.

2.2 Participants

Twenty-one healthy participants (mean age +/- SD: 38.14 +/- 16.21; male/female: 10/11) were recruited at the entrance of the museum. Participants did not wear glasses and did not have major eye problems like strabismus or amblyopia. Given the context of the experiment medical testing of binocular vision was not feasible, but as they denied the major causes of loss of binocular vision, it was quite certain that the population studied was healthy with binocular vision capacity. Their frequency of museum or exhibition visits vary from rarely/occasionally to very often (>20/year), and one identified herself as an artist. For the entire experiment, they were wearing flat shoes. The experiment was approved by the ethics committee of the Centre National de la Recherche Scientifique and adhered to the tenets of the Declaration of Helsinki.[19]. Informed consent was obtained from each participant after the experiment was explained to them.

2.3 Accelerometer

Posture was measured for 30 seconds per condition. A body-fixed sensor (accelerometer) was used. The accelerometer (DynaPort, MiniMod, McRoberts B.V., The Hague, Netherlands) was placed at the participant's lower back (L5). The MiniMod uses a triaxial seismic acceleration sensor (AXXL202, Analogue Devices, Norwood MA, USA). The sensor's full-scale range is +/- 2°. The sampling frequency was set to 100 Hz.

2.4 Procedure

For each condition, participants were required to stand upright, in a standardized Romberg position (feet placed side-by-side with an angle of about 30° and heels separated by about 4 cm). They were instructed to look straight ahead. They were asked to maintain a quiet stance, i.e., with arms held side-by-side, with teeth unclenched and normal breathing. There were two conditions: monocular and binocular, which will be described below.

In the room with the exhibit, observers were placed (one at a time) with their eyes closed in the middle of the room at 3 meters from the corner of the wall, and 1.4 meters from the central X. The experimenters stayed behind them to secure them. In the monocular condition, a 30 second recording was performed while they opened their eyes and the experimenters masked their non-dominant eye. In the binocular condition, a 30 second recording was performed with both eyes open and unmasked. At the end of the recording period, they could exit the room when they wished. After the experiment participants completed a questionnaire that rated their subjective impressions of the work.

It was paramount that the conditions remain in the same order for each participant. It was important that the experiment record the artistic nature of the piece such that the viewers were naïve to the depth oscillation of the work. Therefore, it was important to record the monocular condition before the binocular condition. Each subject participated only once in order to capture their naïve reation to the work; therefore only one trial per participant was recorded.

2.5 Postural Parameters

The following parameters were analyzed: normalized area (NA in mm^2/s), root mean square (rms) of mediolateral body sway (side-to-side distance or rms of M/L distance in mm), rms of anteroposterior body sway (forward-backward distance or rms of A/P distance in mm), rms of mediolateral velocity (side-to-side velocity or rms of M/L velocity in mm/s), rms of anteroposterior velocity (forward-backward velocity or rms of A/P velocity in mm/s), and mean power frequency (MPF in Hz). The first three measures describe the distance the body moved, while the last three are associated to the energy required to stabilize the body.[13]

2.6 Subjective Scores

After viewing both conditions, participants were asked to rate how much they liked the artwork (subjective appreciation) and their sensation of instability (subjective destabilization) on a visual scale, from bottom (not at all) to top (extremely). On this graphical scale, the subject adjusted a cursor, the position of which corresponded to a 0 – 10 number that was recorded. Participants were invited to freely report their impression of the artwork and their subjective experience**.**

2.7 Data Analysis

In a first analysis, we performed a Shapiro-Wilk-W-test to check for normality. As the data were not normally distributed, we performed a Wilcoxon signed-rank test with the factor condition (monocular, binocular viewing) for all postural parameters separately. We also calculated the coefficient of variation (standard deviation / mean) as a percentage for each of the postural parameters in both conditions. In a second analysis, the free reports were examined. We identified the most used words and created groups of participants depending on their use or absence of use of these words and examined whether these groups differed in their subjective scores or postural parameters. For all analyses, the statistical significance was set at $p \leq 0.05$.

3 Results

3.1 Postural Data

3.1.1 Effects of Viewing Condition on Postural Parameters

Table 1 displays the means, standard deviations, and coefficients of variation for all postural measurements studied in both conditions. The Wilcoxon test run on postural parameters revealed that the forward-backward velocity was significantly higher in the monocular than in the binocular condition ($z=2.59$; $p < 0.01$). Figure 1 displays the individual means for forward-backward velocity. Only five participants (out of 21) had lower forward-backward velocity in the monocular rather than binocular condition. The two conditions did not modulate any other postural parameters (all other $p \geq 0.05$).

3.1.2 Variability

The intersubject variability (coefficient of variation, or CV) was higher in the monocular condition than in the binocular condition for three of the parameters (side-to-side velocity, CoV = 92%; side-to-side distance, CV = 152%; normalized area, CV = 266%; see Table 1).

3.2 Free Verbal Reports

Sixteen of the twenty-one participants left free text comments regarding the piece. The free comments were classified into four groups: the first were spontaneous references to depth (6 participants); second were spontaneous references to movement (5 participants); the third were comments not mentioning depth or movement (5 participants); and the fourth those who chose to not leave any free comments (5 participants) (Table 2). Of the sixteen comments, the great majority (eleven) referenced either movement or depth.

There was no evidence for different subjective scores or different postural parameters for those who referenced depth or movement in their free comments.

4 Discussion

This study examined postural parameters when participants observed François Morellet's *Triple X Neonl*y with their dominant eye vs. with both eyes. While the eye condition did not significantly influence postural parameters that are directly related to stability (normalized area, side-to-side distance, forward-backward distance), it significantly modulated a postural parameter related to the energy required to keep the body stable.

More precisely, the results showed that observers had a higher forward-backward velocity with monocular viewing than with binocular viewing, i.e. participants swayed with higher speed in the forward-backward direction with monocular viewing than with binocular viewing. As the forward-backward velocity is associated with the amount of energy required to keep the body stable while holding posture, participants required more energy to keep them stable during monocular viewing than binocular viewing.[13] It is possible that this difference is due to the increased stability that comes from binocular disparity with binocular viewing. The literature on the effects of binocular vs monocular viewing on posture is conflicting [15, 20-25]. Typically, one would expect that posture would be better with binocular vision than with monocular vision when viewing a particular stimulus. Surprisingly, in healthy subjects, this has not been found to be the case: previous studies conducted on participants viewing both a blank wall and a stimulus did not find any statistical difference between binocular and monocular viewing effects on posture.[15, 23] In fact, the only population in which improvement in posture was found with binocular vision was in those with strabismus.[24] However, other studies have found binocular fixation attenuates sway more than monocular fixation, even in darkness [20].

In the present study, the nature of the artwork itself places emphasis on depth and space perception. Due to the lack of binocular disparity with only one eye open, it is more difficult to appreciate the proximity of the central X in space; it appears as if it is in a single plane with the others receding along the wall. As mentioned above, previous posturography data has shown the viewer to be more stable when viewing a proximally placed object; conversely, the observer is less stable when viewing an object placed farther away [8-11]. Therefore, it may be that with monocular viewing, the viewer does not perceive the proximity of the central X, which in turn requires more energy to keep the body stable in the anteroposterior direction as the eye places the central X in a plane that is farther away from the body. With binocular viewing, via binocular disparity, it is possible the viewer perceives the central X as projecting forward in space, closer to the body, and therefore requires less energy to keep the body stable.

The intersubject variability was particularly high in the monocular condition (see the coefficients of variation, Table 1) for three of the six postural parameters (side-to-side velocity, side-to-side distance; normalized area). Most likely, observers better understood the depth of the artwork with binocular vision as the central X proceeds forward in space, so that they could appreciate the X as being closer. Therefore, there was less variation between participants, who were better able to coordinate their posture.

In addition to the posturography differences between the two conditions, it is important to consider the subjective comments of the observers. It is notable that of the 16 comments, 11 spontaneously referenced movement (5 participants) or depth (6 participants). For example, in the monocular condition, one participant reported the work was "*flat*, 2D, a little 3D effect. With both eyes, *huge 3D effect* and it was only after I realized it was really 3D" (Table 2). It is striking that the great majority of these comments reference depth or movement, which mirrors our hypothesis: that the binocular vision of the observer will enhance depth perception; the body senses this depth perception and moves according to the perceived proximity of the central X. It is remarkable that most viewers, by

referencing depth and movement, were on some level conscious of this effect and were in tune with the movement of their body.

In terms of appreciation, previous studies have speculated on why spectators like perceptually challenging images. One study found that insight increases appreciation for the painting or piece by creating a process through which the viewer can mentally elaborate on a piece. Once the viewer has elaborated on the piece, they may or may not find deviations from expectations of how they initially perceived the image or artwork.[26] In this case, we would speculate that binocular viewing of the piece would create a tension between how the viewer originally saw the artwork (as flat) and its true three-dimensional shape in binocular viewing. This insight, according to previous research, may reveal an "-aha!" moment that increases the viewer's appreciation for the piece. In our case, comments from some of the viewers reveal this "aha!" moment: viewer's reported they were "surprised"; that they only realized depth in the binocular condition; that there was a perception of "space" in the binocular condition, and one participant even exclaimed her surprise in the binocular condition. (Table 2) Nevertheless, there was no correlation between appreciation and movement, and the conditions of the experiment prevented us from asking participants to rate their appreciation of the piece in both conditions. Additionally, there was no difference in appreciation scores for those whose comments specifically referenced depth, space, or surprise in the second condition. This may be the simple fact that we had a small sample size once we split the groups by subjective comments, or due to the fact that we had a rather crude way of examining the subjective reactions of our subjects to their piece (simple comments and an appreciation score from 1-10) that are also difficult to quantify. We may not have also given them enough exposure or enough time to reflect on the piece, or, enough time for elaboration. A different experiment with the same work could have separated viewers into two groups: one who were allowed to look at the piece in both conditions, and one who were allowed only the monocular condition and therefore were deprived of the predicted "-aha!".

This study is unique as it is one of the few studies performed to date, to our knowledge, that can examine the artist's intended effect on the observer. Although it is nearly impossible to discover an artist's intention, in contemporary art, interviews and writings by the artist can help make the intended meaning of the work clearer. François Morellet himself agrees it can be difficult to find an artist's meaning in his or her work, writing, "works of fine art have never succeeded in conveying to viewers the message, the philosophy, the poetry, or even the sensibility that the creators believed they had put into it".[27] For Morellet, it is extremely difficult for the artwork itself to impose a meaning onto the viewer when the work is separated from the observer. Instead, by creating his art, he makes "superfluous (therefore artistic) things… simple and obvious systems that often appeal to the actual coincidence or involvement of the viewer"[27]. His works take the viewer into account and "minimize [the artist's] intervention… everything you find, apart from [the artist's] small systems, will be yours as a viewer belongs"[27]. Therefore, for Morellet, without the viewer's interaction, the work of art remains incomplete and the observer plays an integral part in the success of the piece of art.

This is particularly poignant with regards to *Triple X Neonly*. Through her visual system, the viewer herself fulfills the complexity of the piece, the flickering of the central X between distal (monocular viewing) and proximal (binocular viewing). Thus, the artwork does not exist without the viewer. In analyzing both the subjective comments and objective posturography measurements, it is clear the observers understood the manipulation of the piece. Many observers spontaneously commented on the creation of movement or depth, and the work succeeded in modulating the viewer's body sway as their participation in the illusion manipulated their perception and their body. It is important to note that our experiment explores the two extremes of monocular and binocular vision. As a casual viewer, one may not think to observe the work with only monocular vision. However, as the eyes

explore the piece, there are times in which the two eyes are not completely coordinated, disrupting binocular vision, an effect akin to the monocular condition, causing the central X to oscillate in space. Therefore, as the perceived artwork's depth oscillates, forcing the observer to move, one could consider the work to be complete.

Our findings reflect the larger philosophy of GRAV. While these artists strove to manipulate the perceptual systems of their viewers through their artwork, creating an aesthetic field dependent on time and space, there have been few studies that have quantified the physiologic effect of the field on the viewer. Indeed, as the artist group hypothesized, the unstable binocular viewing system creates a flickering in perception between two and three-dimensions, which perpetuated throughout the body through an induced unstable oscillation in the viewer; the aesthetic field is completed and the artwork comes into existence.

5 Limitations

Our study had its limitations starting from the small number of participants tested (21). Although this study sought to analyze the initial response to viewing an artwork for the first time, given the inherent variability in postural measurements, the study is limited by the number of observations per participant. Participants could have been asked more specific questions about their experience of the artwork (e.g., record each time they noticed the artwork oscillate) or could have been asked to describe their experience during the recording. However, it was important for this study that the viewers not be primed for their response to the piece or be distracted from the full experience of the work. A two-dimensional control could have been added. It would have been useful to record the stereoacuity of each participant. It also would have been interesting to record eye movements while recording posture, to determine if there were any changes in posture related to where the participants were looking. This is certainly something we are considering for a follow up study. Finally, due to our posturography device, we were unable to note postural changes over the thirty-second viewing period. This would yield information regarding stances that are predictable and deterministic (stable) vs those with a smaller amplitude that are more chaotic (unstable). It would be interesting to utilize other equipment in future studies to better understand the temporal dynamics of the subjects' posture.

6 Conclusion

Despite the limitations mentioned previously, we feel that this study offers a unique description of posturography in the real-life three-dimensional gallery environment. Most strikingly, this study is an extraordinarily rare opportunity to see an artist's vision described in objective measurement. Future endeavors to describe the physiologic response to artwork should attempt to overcome these limitations, particularly those with respect to temporality. Studies of this sort are extremely difficult to execute given the necessity of the regulations imposed by museums and the difficulty of obtaining objective measurements in the gallery space. It is incredibly important to study the human response to artwork, and this study is one preliminary example of what can be achieved with this type of experimental set-up in the real museum environment. More studies in this vein should be encouraged such that we can better understand the human response to art.

The findings from this study confirm to a large extent that it is possible to measure a viewer's objective response to a work of art through postural measurements. The viewer's subjective comments suggest that binocular viewing provides a better depth perception of the piece, therefore allowing the central X to appear more proximal to the viewer. In monocular viewing, our objective data suggests the lack of perception of this proximity created a greater velocity of anteroposterior sway in the viewer, requiring the viewer to expend more energy to keep themselves stable. Finally,

this study makes an argument for the importance of scientific study of the impact art has on the observer. It is clear these scientific measurements can provide a deeper understanding of the study of art, artistic intention, and art history. Future studies should concentrate on the intersection between physiologic measures such as postural movements and aesthetic appreciation.

It is curious that Morellet created this piece in 2012, long after the height of the GRAV movement that was so influential throughout the 1960s. By creating art that inherently relied on human perception, the leaders of GRAV considered their art to be egalitarian; the visual system that permits the aesthetic field to come into existence is universal.[2] In the 21st century, a time in which artworks sell for record prices at auction, the art world appears to have become a hyper-elite community which is inaccessible to most. In this world in which the cult of the artist seems more inflated than ever, and in which art feels more removed from the populus than ever, it matters that Morellet provides a reminder that the artwork resides nowhere else but intrinsically with the viewer who beholds it.

7 Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

8 Author Contributions

L.M.W. wrote the main manuscript text, conducted the statistical analysis, and prepared the figures and tables. C.A. edited the manuscript. A.M. conducted the experiment. M.V. and Z.K. conceived of the experimental design. Z.K. initiated and supervised the study. All authors reviewed the manuscript.

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11 Data Availability Statement

The datasets generated during and analyzed during the current study are available from the corresponding author on reasonable request.

12 References

1. Bishop C. *Artificial hells : participatory art and the politics of spectatorship*. Verso Books; 2012:382 pages.
2. Alberro A. *Abstraction in reverse : the reconfigured spectator in mid-twentieth-century Latin American art*. The University of Chicago Press; 2017:x, 309 pages.

3. Pierre A. *De l'instabilite : perception visuelle, corporelle de l'espace dans l'environment cinetique*. Les Cahiers du Mnam; 2002:pp. 40 - 69 : ill.
4. Masson GS, Busettini C, Miles FA. Vergence eye movements in response to binocular disparity without depth perception. *Nature*. Sep 18 1997;389(6648):283-6. doi:10.1038/38496
5. Rashbass C, Westheimer G. Disjunctive eye movements. *J Physiol*. Dec 1961;159:339-60.
6. Poggio GF, Fischer B. Binocular interaction and depth sensitivity in striate and prestriate cortex of behaving rhesus monkey. *J Neurophysiol*. Nov 1977;40(6):1392-405. doi:10.1152/jn.1977.40.6.1392
7. Howard IP. *Seeing in depth: 2*. vol 2. Oxford University Press; 2008.
8. Aoki O, Otani Y, Morishita S, Domen K. Influence of gaze distance and downward gazing on postural sway in hemiplegic stroke patients. *Exp Brain Res*. Feb 2014;232(2):535-43. doi:10.1007/s00221-013-3762-3
9. Munafo J, Curry C, Wade MG, Stoffregen TA. The distance of visual targets affects the spatial magnitude and multifractal scaling of standing body sway in younger and older adults. *Exp Brain Res*. Sep 2016;234(9):2721-30. doi:10.1007/s00221-016-4676-7
10. Paulus WM, Straube A, Brandt T. Visual stabilization of posture. Physiological stimulus characteristics and clinical aspects. *Brain*. Dec 1984;107 (Pt 4):1143-63.
11. Paulus W, Straube A, Krafczyk S, Brandt T. Differential effects of retinal target displacement, changing size and changing disparity in the control of anterior/posterior and lateral body sway. *Exp Brain Res*. 1989;78(2):243-52.
12. Kapoula Z, Adenis M-S, Lê T-T, Yang Q, Lipede G. Pictorial depth increases body sway. *Psychology of Aesthetics, Creativity, and the Arts*. 2011;5(2):186-193.
13. Vernet M. MA, Kapoula Z. "Postural and Emotional Impact of
Carsten Höller's Artwork "Light Corner". In: Kapoula Z. VE, Renoult J. AMe, eds. *Exploring Transdisciplinarity in Art and*
Sciences. Springer, Cham; 2018:165-175.
14. Chiba R, Takakusaki K, Ota J, Yozu A, Haga N. Human upright posture control models based on multisensory inputs; in fast and slow dynamics. *Neurosci Res*. Mar 2016;104:96-104. doi:10.1016/j.neures.2015.12.002
15. Le TT, Kapoula Z. Distance impairs postural stability only under binocular viewing. *Vision Res*. Oct 2006;46(21):3586-93. doi:10.1016/j.visres.2006.06.018
16. Winter DA, Prince F, Frank JS, Powell C, Zabjek KF. Unified theory regarding A/P and M/L balance in quiet stance. *J Neurophysiol*. Jun 1996;75(6):2334-43. doi:10.1152/jn.1996.75.6.2334
17. Winter DA, Patla AE, Ishac M, Gage WH. Motor mechanisms of balance during quiet standing. *J Electromyogr Kinesiol*. Feb 2003;13(1):49-56.
18. Day BL, Steiger MJ, Thompson PD, Marsden CD. Effect of vision and stance width on human body motion when standing: implications for afferent control of lateral sway. *J Physiol*. Sep 1993;469:479-99.
19. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. *Jama*. Nov 27 2013;310(20):2191-4. doi:10.1001/jama.2013.281053
20. Fox CR. Some visual influences on human postural equilibrium: binocular versus monocular fixation. *Percept Psychophys*. May 1990;47(5):409-22. doi:10.3758/bf03208174
21. Barela JA, Sanches M, Lopes AG, Razuk M, Moraes R. Use of monocular and binocular visual cues for postural control in children. *J Vis*. Oct 17 2011;11(12)doi:10.1167/11.12.10
22. Moraes R, Lopes AG, Barela JA. Monocular vision and increased distance reducing the effects of visual manipulation on body sway. *Neurosci Lett*. Sep 4 2009;460(3):209-13. doi:10.1016/j.neulet.2009.05.078

23. Isotalo E, Kapoula Z, Feret PH, Gauchon K, Zamfirescu F, Gagey PM. Monocular versus binocular vision in postural control. *Auris Nasus Larynx*. Mar 2004;31(1):11-7. doi:10.1016/j.anl.2003.10.001
24. Gaertner C, Creux C, Espinasse-Berrod MA, Orssaud C, Dufier JL, Kapoula Z. Benefit of bi-ocular visual stimulation for postural control in children with strabismus. *PLoS One*. 2013;8(4):e60341. doi:10.1371/journal.pone.0060341
25. Smetanin BN, Popov KE, Kozhina GV. Specific and Nonspecific Visual Influences on the Stability of the Vertical Posture in Humans. journal article. *Neurophysiology*. January 01 2004;36(1):58-64. doi:10.1023/B:NEPH.0000035970.59438.cf
26. Muth C, Carbon CC. The aesthetic aha: on the pleasure of having insights into Gestalt. *Acta Psychol (Amst)*. Sep 2013;144(1):25-30. doi:10.1016/j.actpsy.2013.05.001
27. Morellet F. Galerie M Bochum. November, Accessed November, 2018. text-indent:-.5in"> www.m-bochum.de/artist_info_en.php?SID=ef7O0jR2weoE&aid=31&aname=Fran%E7oisMorellet.

Figure 1

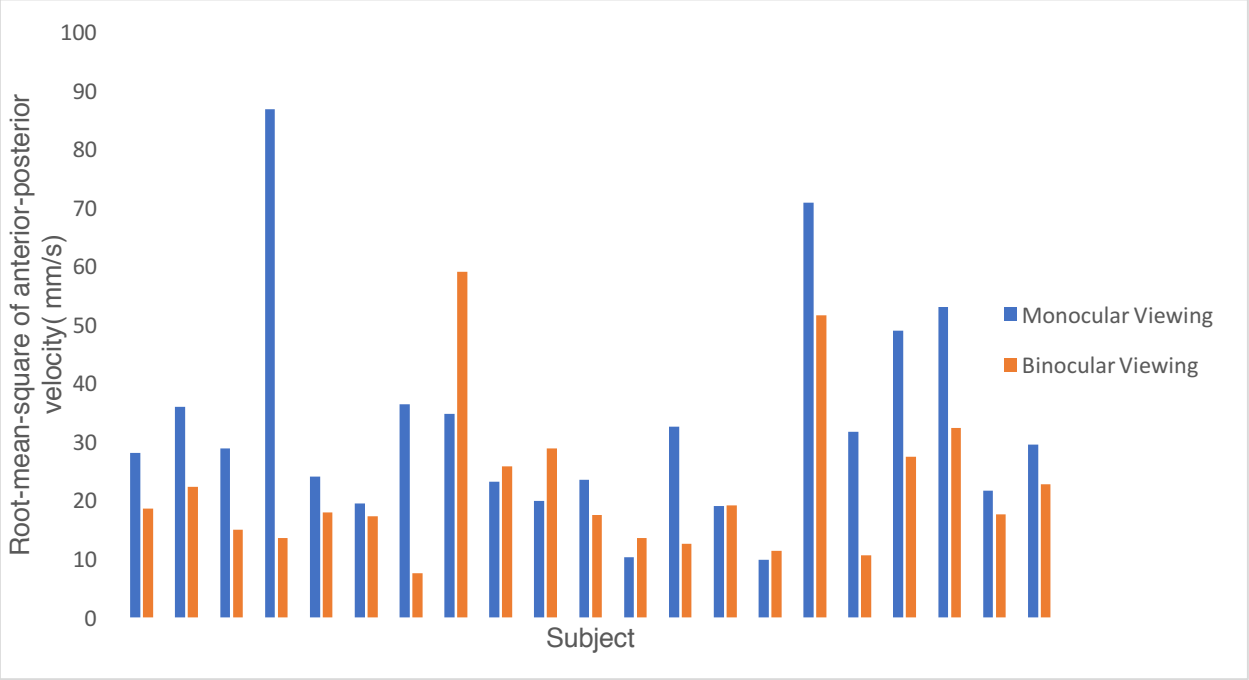
Root-mean-square of anterior-posterior velocity(mm/s)
100
90
80
70
60
50
40
30
20
10
0
Subject
Monocular Viewing
Binocular Viewing

Figure legend

Fig. 1 Root-mean-square of anteroposterior velocity for all participants in both conditions: The rms AP velocity was the only postural parameter that was significantly different between the two conditions ($p < 0.01$).

Table 1: Means, standard deviations, and coefficients of variation for all postural measurements studied in both conditions. AP: anteroposterior; ML: mediolateral; MPF: mean power frequency

	Condition 1 (Monocular Viewing)			Condition 2 (Binocular Viewing)			P-Value
	Mean	Standard Deviation	Coefficient of Variation (%)	Mean	Standard Deviation	Coefficient of Variation (%)	
MPF (Hz)	6.66	1.32	20	6.53	1.34	20	0.554
rms AP velocity (mm/s)	**32.75**	18.79	57	21.99	12.81	58	**0.009****
rms ML velocity (mm/s)	12.60	11.58	**92**	9.07	6.76	75	0.268
rms AP distance (mm)	6.19	3.07	50	6.30	2.74	44	0.538
rms ML distance (mm)	2.55	3.88	**152**	1.54	0.55	36	0.763
Normalized Area (mm^2/s)	8.71	23.17	**266**	3.71	2.38	64	0.970

Table 2 Subjective scores, comments, and grouping of participants. Appreciation and destabilization scores range from 0 (not at all) to 10 (extremely). Words in bold relate to depth or movement. Group 1 includes participants who referenced depth; Group 2 includes participants who referenced movement; Group 3 includes participants who did not reference neither depth nor movement; Group 4 includes participants who did not leave comments.

Subject	Age	Sex	Height (cm)	Weight (kg)	Appreciation	Destabilization	Subjective Comments	Group Number
1	27	M	171	64	2.5	5.2	Did not recognize the distance and the **depth** even with my eyes open.	1
2	42	F	177	67	2.4	0.2	The experiment is interesting, It allows me to better understand the **binocular** aspect of the work	1
3	52	M	177	81	8.4	1.6	In the second condition, sensation of **space** as if I found myself in a bubble	1
4	26	M	175	66	6.9	5.8	Surprised when I opened my eyes for the first time (very **unstable**)	2
5	24	M	183	70	8.5	7.8	In condition 1 I didn't see the **depth**, weird. Condition 2 I realized it.	1
6	37	F	165	60	6.4	0	[Exclaimed when she opened both eyes] One eye closed, **flat**, 2D, a little 3D effect. With both eyes, **huge 3D effect** and it was only after I realized it was really 3D	1
7	28	F	160	54	10	6.5	The lines of the bottom and the top disappeared. **I moved backwards** for the 2 conditions I think.	2
8	19	M	168	68	8	7.5	**I moved backwards** when I opened both my eyes	2
9	40	F	181	63	3.9	3	The neon lights really existed, but after a while I felt they did not exist. A diffuse halo was created	3
10	20	M	180	75	5.9	0.6	Especially enjoyed condition 1	3
11	20	F	158	59	10	10		4
12	20	M	167	54	3.5	7.3	Already seen. Condition 1: Appeared as if it were in the corner of the walls and along the walls. Condition 2: I saw there were **two layers.**	1
13	51	F	160	46	5.6	8.2		4
14	66	M	180	88	7.6	3.4	I found it not bad, interesting enough, geometric, the light is good	3
15	65	M	183	78	6.3	0		4
16	61	F	163	57	7.2	2	It was pretty strange	3
17	40	F	168	58	6	5.25	I did orthoptics	3
18	20	F	165	53	5	3		4
19	55	F	157	60	3	0		4
20	33	F	164	70	3.6	10	It's beautiful. In both conditions: **vibrated** a little, especially condition 2.	2
21	55	M	183	73	9.5	2.2	I really like Morellet, I'm a fan. Static objects put us in **motion**.	2
Average	38.14		170.71	64.95	6.2	4.26		
Standard Deviation	16.21		8.96	10.32	2.41	3.37		