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The influence of sensorimotor experience on beauty evaluation of preschool children.

It is well established that the observation of works of art is closely related to a sensorimotor component. Indeed, an important contribution to aesthetic experience comes from the activation of embodied mechanisms in response to the viewed stimulus, which include the simulation of actions, emotions and bodily sensations [1]. This mechanism of embodied simulation establishes a relationship of sharing between the observer's body and the the artistic representation. We do not simply visually perceive art but the body itself contributes to the perception of art and to the creation of an aesthetic condition.

Much research in recent years has shown a close functional link between the observation of artworks and the involvement of sensory and motor cortical areas. The interpretation of sensorimotor activation in observers' brains is that it evokes a representation of the gesture that generated the artwork, in the case of abstract art, or a simulation of the bodily movements represented in the artwork, in the case of figurative art. In both cases, the mirror mechanism has been called into play as the neural basis of this bodily representation.

Two EEG experiments investigated the sensorimotor cortical responses during observation of visual abstract artworks like the cuts on canvas by Lucio Fontana [2] and the brush strokes of Franz Kline [3]. The results showed a significant response of beholders' sensorimotor cortices, demonstrating that the intrinsic dynamism of the observed abstract artworks generates the motor simulation of the artist's gesture in the brain of beholders.

Differently, Di Dio and collaborators observed activation of the motor cortex during viewing of paintings both representing acting human figures and landscapes. They proposed that the motor resonance was mediated by the mirror mechanism and that was driven by viewing portrayed human actions, while the motor activation evoked during observation of landscapes was likely due to the motor imagery of exploratory behavior elicited by the represented landscape context [4].

All these results show that the observation of artworks establishes a bodily relation between viewers and the dynamic properties of the images.

Neuroimaging studies demonstrate that the observation of other individuals' somatosensory experiences and emotional facial expressions recruits sensory, motor and emotional brain areas involved also in the first-person experience of the same state [5] [6] [7] [8] [9] and that this shared neural base for experiencing and observing emotions is consistent also when the emotional content is depicted in artworks.

Regarding the emotional involvement in response to observing emotions expressed in art, Ardizzi et al [10] did an fMRI study in which they presented participants with faces expressing pain either from works of art or photographs of unknown people. The goal of the experiment was to investigate whether there were any specificities in the perception of pain when expressed in art; in other words, they investigated the empathy for pain elicited by artistic and non-artistic painful facial expressions. The study demonstrated that the activation of empathy for pain brain regions can be elicited by both artistic and non-artistic representations of facial pain; and provides evidence that the communal neural network for the first- and third-person emotional experiences can also be triggered by art emotional content. See Figure 1 showing the stimuli employed.

Of all the studies that have investigated the role of the body in art experience, in this pre-paper I will illustrate those that belong to two experimental categories, namely, those in which participants were asked to give their explicit aesthetic evaluation and those in which their active

motor involvement was required. The reason for my choice is to clarify the basis from which we carried out the experiment that I will illustrate during the seminar. The data I will present in the seminar were collected with the goal of investigating whether there is a direct causal link between an active sensorimotor experience and the formulation of aesthetic judgment in children.

In relation to the explicit aesthetic judgment category of experiments, during the study just described [10] participants were asked to rate how "artistically beautiful" the images of faces were, with the goal of investigating whether there was a relationship between their aesthetic judgment and cortical activation for pain. The results showed that the greater the activation in cortical regions involved with pain perception the higher the aesthetic judgment score given to artworks expressing pain. Only for artworks was there a correlation between cortical activation and aesthetic judgment, while it was missing in photographs.

In the same framework, Mastandrea and Umiltà [11] presented 10 different images of Futurist paintings and asked participants to rate how much movement they perceived in the images, how much they liked them, and how beautiful they were. The authors considered Liking as a subjective aesthetic appraisal and Beauty as an objective aesthetic appraisal. The additional aim was to investigate the perceived dynamism and aesthetic quality of these Futurist artworks in function of their title. Ten Futurist artworks with a movement-related word in the original title were selected for this study (see Figure 2). The titles were manipulated to obtain four conditions for each painting: the original title with the movement-related word; the increased title, where an adjective was added to increase the sense of dynamism; the decreased title, where the movement-related word was eliminated; no title. Results showed that the manipulation of the title had a specific effect on the evaluation of the movement perceived: the paintings presented with the original title (e.g., The girl running on the balcony) or with the increased title (e.g., The girl running fast on the balcony) received significant higher scores compared to the paintings

presented with no title or with a neutral title (e.g., The girl). Even more interestingly, results demonstrated that as movement ratings increased, both Liking and Beauty ratings also increased, thus showing a positive correlation between aesthetic evaluation and perceived motion.

In addition, a recent transcranial magnetic stimulation (TMS) study using a set of paintings characterized by different degrees of dynamism [12] revealed that the more the painting conveyed the impression of a dynamic human action, the higher was the excitability of beholders' cortical motor system and the more the artwork was liked.

All the experiments described so far have used as stimuli digital reproductions of artworks that were not originally created in this medium. To overcome this limitation, we carried out an experiment using digital artworks by artist Ori Gersht (<https://www.origersht.com/>) [13], (see Figure 3). We asked the participants how much they wanted to touch the images, how close they felt them to their bodies, how beautiful they were, and how much they liked them. Since both aesthetic evaluations were positively correlated with Touch and Proximity scores, we empirically established a clear association between the sense of presence, involvement of the viewer's body, and aesthetic judgments about the content of digital artworks. The results support the role of embodied simulation in the observation of digital visual art and highlight its role during aesthetic experience.

In relation to active motor involvement category of experiments, the first study that investigated the relationship between an active motor task and aesthetic judgments was done by Leder and colleagues [14] who asked participants to make a hand movement congruent or incongruent with the painting style they were observing and to express their aesthetic liking for the works, the hypothesis being that the perception of a painting style elicits motor simulations of congruent hand movements in the observer. The motor simulations triggered by the observation of the paintings were enhanced or interfered with by simultaneously performing hand movements that

either resembled or did not resemble the movements made by the artists when creating the paintings with different styles (e.g. pointillism vs. brushstrokes). When the participants' hand movements were congruent with those performed by the artists to accomplish the artwork, the aesthetic liking given by the participants was significantly higher. They thus demonstrated the existence of a motor simulation component during the aesthetic experience.







A more recent electromyography (EMG) study explored the relationship between beholders' sensorimotor engagement with the emotional content of artworks and the aesthetic judgment of their beauty [15]. The participants in the study judged the artistic beauty of images of Renaissance and Baroque paintings depicting painful and neutral facial expressions in two conditions (see Fig. 1). In one condition, they were asked to actively contract the *corrugator supercillii* facial muscles, which is activated when people experience and observe negative emotions, an action that could be either congruent, in case of pain observation, or incongruent, in case of neutral expression, with the observed depicted faces. In the other condition, participants were asked to keep their facial muscles relaxed. The results showed a significant increase in the aesthetic rating of paintings showing painful facial expressions during the congruent activation of the corrugator muscles, while no effect was detected when rating neutral facial expressions. These findings corroborate the hypothesis of the existence of a constitutive relation between the bodily dimension of the beholders and their explicit aesthetic evaluation of works of art.

During my seminar I will present the results of an experiment exploring the relationship between sensorimotor and aesthetic experience in children. In this study, we investigated for the first time whether sensorimotor experience concurs to the formation of an aesthetic evaluation in preschool children. Recent developmental research demonstrated the presence of spontaneous sensorimotor simulation responses early in life. The youngest sample in which sensorimotor simulation was observed through mu rhythm desynchronization in response to action observation

were 4-month-olds [16]. The existence of a sensorimotor resonance mechanism has also been demonstrated later in 10-year-old children with a study done to investigate the temporal pattern of the Event-related potentials (ERPs) and their topographic map, during observation of reaching/grasping actions in which the availability of visual information was manipulated [17].

Although these processes have been extensively demonstrated in adult populations, no studies to date have investigated whether sensorimotor simulation can participate to the formation of aesthetic judgment in children. To accomplish this goal, a group of children rated the tactile, visual and beauty proprieties of two artefacts made by two different sculpting natural materials after having manipulated only one of them. If sensorimotor experience plays a specific role in the formation of the aesthetic judgment, we expected a stronger modulation of the beauty ratings offered to the artefact made by the handled material only.

Figure 1: stimuli employed in [10] and [15]

Neutral Stimuli						
						
Author	Moretto da Brescia	Lorenzo Lotto	Antonello da Messina	Annibale Carracci	Sandro Boticelli	Hans Memling
Title	Portrait of Fortunato	Portrait of a Gentleman in his study	Portrait of Man	Self-portrait	Portrait of a Young Man	Portrait of a Man with a Roman Coin
Collocation	National Gallery (London)	Academy Gallery (Venice)	National Gallery (London)	Guelpha Foundation (Turin)	National Gallery (London)	Royal museum of Fine Arts of Belgium (Antwerp)
Year	1542	1535	1476	1593	1483-1484	1480







Pain Stimuli						
						
Author	Caravaggio	Theodoor Rombouts	Caravaggio	Giudo Reni	Gregorio Martinez	José de Ribera
Title	David and Goliath	Prometheus	Judith Beheading Holofernes	Apollo and Marsia	Prometheus bound	Martyrdom of Saint Philip
Collocation	Borghese Gallery (Rome)	Royal museum of Fine Arts of Belgium (Antwerp)	Barberini Palace (Rome)	Tolosa, Musée des Augustins	The Prado Museum (Madrid)	The Prado Museum (Madrid)
Year	1609-1610	1590-1596	1597-1602	1618-1619	1590-1596	1639

Figure 2: example of some stimuli used in [12]



G. Balla. Bambina che corre sul balcone



G. Balla. Dinamismo di un cane al guinzaglio



C. Carrà. Dinamismo di una nuotatrice

Figure 3: example of some stimuli used in [13]



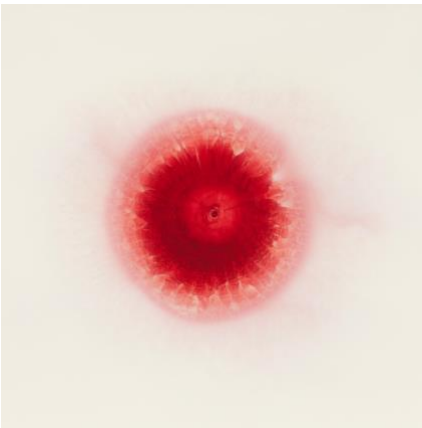
Blow Up 01



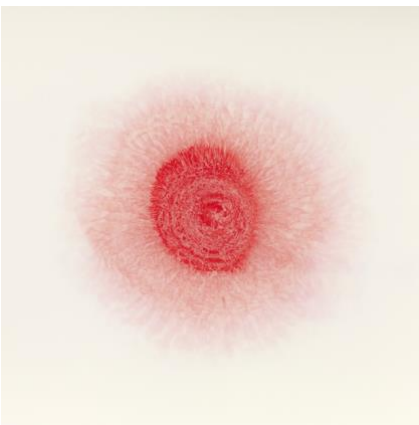
Blow Up 04



Fusion-J03



Love Me Love Me Not_06



Love Me Love Me Not_12

References

- 1) Freedberg D, Gallese V. Motion, emotion and empathy in esthetic experience. *Trends Cogn Sci.* 2007 May;11(5):197-203. doi: 10.1016/j.tics.2007.02.003. Epub 2007 Mar 7. PMID: 17347026.
- 2) Umilta', M. A., Berchio, C., Sestito, M., Freedberg, D., & Gallese, V. (2012). Abstract art and cortical motor activation: an EEG study. *Frontiers in human neuroscience*, 6, 311. <https://doi.org/10.3389/fnhum.2012.00311>

- 3) Sbriscia-Fioretti, B., Berchio, C., Freedberg, D., Gallese, V., & Umiltà, M. A. (2013). ERP modulation during observation of abstract paintings by Franz Kline. *PLoS one*, 8(10), e75241. <https://doi.org/10.1371/journal.pone.0075241>
- 4) Di Dio C, Ardizzi M, Massaro D, Di Cesare G, Gilli G, Marchetti A, Gallese V. Human, Nature, Dynamism: The Effects of Content and Movement Perception on Brain Activations during the Aesthetic Judgment of Representational Paintings. *Front Hum Neurosci*. 2016 Jan 12;9:705. doi: 10.3389/fnhum.2015.00705. PMID: 26793087; PMCID: PMC4709505.
- 5) Carr L, Iacoboni M, Dubeau MC, Mazziotta JC, Lenzi GL. Neural mechanisms of empathy in humans: a relay from neural systems for imitation to limbic areas. *Proc Natl Acad Sci U S A*. 2003 Apr 29;100(9):5497-502. doi: 10.1073/pnas.0935845100. Epub 2003 Apr 7. PMID: 12682281; PMCID: PMC154373.
- 6) Wicker B, Keysers C, Plailly J, Royet JP, Gallese V, Rizzolatti G. Both of us disgusted in My insula: the common neural basis of seeing and feeling disgust. *Neuron*. 2003 Oct 30;40(3):655-64. doi: 10.1016/s0896-6273(03)00679-2. PMID: 14642287.
- 7) Ebisch SJ, Perrucci MG, Ferretti A, Del Gratta C, Romani GL, Gallese V. The sense of touch: embodied simulation in a visuotactile mirroring mechanism for observed animate or inanimate touch. *J Cogn Neurosci*. 2008 Sep;20(9):1611-23. doi: 10.1162/jocn.2008.20111. PMID: 18345991.
- 8) Ebisch SJ, Ferri F, Salone A, Perrucci MG, D'Amico L, Ferro FM, Romani GL, Gallese V. Differential involvement of somatosensory and interoceptive cortices during the observation of affective touch. *J Cogn Neurosci*. 2011 Jul;23(7):1808-22. doi: 10.1162/jocn.2010.21551. Epub 2010 Jul 28. PMID: 20666597.
- 9) Caruana F, Avanzini P, Gozzo F, Pelliccia V, Casaceli G, Rizzolatti G. A mirror mechanism for smiling in the anterior cingulate cortex. *Emotion*. 2017 Mar;17(2):187-190. doi: 10.1037/emo0000237. Epub 2016 Nov 17. PMID: 27854442.
- 10) Ardizzi M, Ferroni F, Umiltà MA, Pinardi C, Errante A, Ferri F, Fadda E, Gallese V. Visceromotor roots of aesthetic evaluation of pain in art: an fMRI study. *Soc Cogn Affect Neurosci*. 2021 Nov 15;16(11):1113-1122. doi: 10.1093/scan/nsab066. PMID: 33988702; PMCID: PMC8599194.
- 11) Mastandrea S, Umiltà MA. Futurist Art: Motion and Aesthetics As a Function of Title. *Front Hum Neurosci*. 2016 May 17;10:201. doi: 10.3389/fnhum.2016.00201. PMID: 27242471; PMCID: PMC4868917.
- 12) Fiori F, Plow E, Rusconi ML, Cattaneo Z. Modulation of corticospinal excitability during paintings viewing: A TMS study. *Neuropsychologia*. 2020 Dec;149:107664. doi: 10.1016/j.neuropsychologia.2020.107664. Epub 2020 Oct 29. PMID: 33130160.
- 13) Calbi M, Aldouby H, Gersht O, Langiulli N, Gallese V, Umiltà MA. Haptic Aesthetics and Bodily Properties of Ori Gersht's Digital Art: A Behavioral and Eye-Tracking Study. *Front Psychol*. 2019 Nov 7;10:2520. doi: 10.3389/fpsyg.2019.02520. PMID: 31787915; PMCID: PMC6853892.
- 14) Leder H, Bär S, Topolinski S. Covert painting simulations influence aesthetic appreciation of artworks. *Psychol Sci*. 2012 Dec;23(12):1479-81. doi: 10.1177/0956797612452866. Epub 2012 Nov 8. PMID: 23137968.
- 15) Ardizzi M, Ferroni F, Siri F, Umiltà MA, Cotti A, Calbi M, Fadda E, Freedberg D, Gallese V. Beholders' sensorimotor engagement enhances aesthetic rating of pictorial facial expressions of pain. *Psychol Res*. 2020 Mar;84(2):370-379. doi: 10.1007/s00426-018-1067-7. Epub 2018 Aug 3. PMID: 30073408.

- 16) Virji-Babul N, Rose A, Moiseeva N, Makan N. Neural correlates of action understanding in infants: influence of motor experience. *Brain Behav.* 2012 May;2(3):237-42. doi: 10.1002/brb3.50. PMID: 22741097; PMCID: PMC3381628.
- 17) Berchio C, Rihs TA, Michel CM, Brunet D, Apicella F, Muratori F, Gallese V, Umiltà MA. Parieto-frontal circuits during observation of hidden and visible motor acts in children. A high-density EEG source imaging study. *Brain Topogr.* 2014 Mar;27(2):258-70. doi: 10.1007/s10548-013-0314-x. Epub 2013 Sep 12. PMID: 24026809.