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Spirit Behind Appearance: Facial Motion Increases Facial Attractiveness Through Perceived Vitality

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Artists show the beauty of life by depicting bodily movement, suggesting vitality. However, the role of vitality in ratings of facial attractiveness remains understudied. This study explored whether vitality led to the higher attractiveness of dynamic faces. We manipulated facial motion into dynamic, scrambled, and static conditions (Experiments 1 and 2) and primed facial vitality with vitality labels (Experiment 2). Participants rated vitality (Experiments 1 and 2), attractiveness (Experiments 1 and 2), and subjective processing fluency (Experiment 2). Both Experiments 1 and 2 found dynamic faces had higher vitality and attractiveness than static ones, and vitality mediated the relationship between motion and facial attractiveness. Subjective processing fluency had no mediating effect between motion and facial attractiveness. In Experiment 3, we not only replicated this mediating effect with human face stimuli but also generalized this mediating effect to nonface stimuli (animal, inanimate object, and plant) with different vitality forms (exploding, fading, and pulsing). Based on the results, we discuss the aesthetic value of vitality and explain how dynamic stimuli enhance attractiveness.

Keywords: facial attractiveness, aesthetics, dynamic, vitality, animacy

Supplemental materials: https://doi.org/10.1037/aca0000551.supp

Which aspects of an artistic creation attract the eye of the viewer? Socrates declared that the faithful imitation of the various affectations of bodily action imparts a particular pleasure to the viewer; successful imitation brings statues to life (Xenophon, 1897/2013). The history of aesthetics suggests that beauty seems to go beyond appearance to the spirit behind it, as shown in the portrayal of bodily movements (Eco, 2004/2007). For example, the classic sculpture *Discobolus* depicts a man throwing a discus, and its intense movements show the beauty of a human body that is full of vitality.

Vitality is defined as "vital force, power of enduring or continuing, mental or physical vigour, animation, liveliness" (Oxford University Press, n.d.). From a psychological perspective, Stern (2010) considered vitality as the manifestation of life, a mental creation, and a subjective experience. It takes on different vitality forms (physical actions and mental movements, etc.) and permeates our daily lives, psychology, and even the arts (Stern, 2010). Vitality is the perception of not only aliveness and energy involving active, arousal, or caloric reserves but also the possessing enthusiasm and spirit (Bostic et al., 2000; Ryan & Frederick, 1997).

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Before we introduce previous research about vitality, we will clarify the use of *vitality* and that of *animacy* in the present paper. Some previous research focusing on the sense of life has used the concept of *animacy* to express how lifelike a stimulus is (e.g., Chang & Troje, 2008; Koldewyn et al., 2014; Looser et al., 2013; Looser & Wheatley, 2010; Rosa-Salva et al., 2016; Szego & Rutherford, 2007). As described above, vitality is a wider concept than animacy because it describes not only the animated character but also the capacity to live and the internal states (e.g., enthusiasm and spirit) of a stimulus.

Motion is a cue to vitality. Motion comes with the perception of time (the start, duration, and end of an action), force(s) behind it, space, and intention/directionality, which together give rise to an experience of the vitality (Stern, 2010). These four basic components of motion constitute the vitality forms (Di Cesare et al., 2014; Stern, 2010) and characterize how the motion is performed (Di Cesare et al., 2016). Different patterns of motion give rise to the different vitality forms, such as "exploding" (force intensity increases over time), "fading" (intensity decreases over time), and "pulsing" (intensity fluctuates slowly over time) (Stern, 2010). These dynamic forms of vitality allow observers to recognize the differential internal affective and cognitive states of an agent and thus affect the behavior of observers (see Di Cesare et al., 2020 for a review). For example, compared with a rude action, a gentle action manifests the agent's kinder mood and stronger willingness to interact, which lead to the observer's subsequent motor behavior with narrower trajectory and lower velocity in response to the action (Di Cesare et al., 2017). In addition, people can perceive animacy from coherent or scrambled biological motion (Chang & Troje, 2008) and the internal energy source of the moving objects from their motion cues (Rosa-Salva et al., 2016; Stewart, 1982).

Humans have a natural preference for moving objects, which may be due to the vitality contained in the motion. For example, infants develop a preference for biological motion at 4 months of age (Fox & McDaniel, 1982), and biological motion gives rise to a sensation of animacy (Chang & Troje, 2008). Adults prefer human-like to uniform movements (Chamberlain et al., 2022), which may enable them to perceive the internal energy of the objects (Rosa-Salva et al., 2016; Stewart, 1982). In addition, the time-based arts (dance, theater, etc.), which contain dynamic forms of vitality, move people by the expressions of vitality that resonate in them (Stern, 2010). Research in neuroscience provides further support. Zhao et al. (2020) found dynamic landscapes were more attractive than static landscapes and triggered stronger activation of the bilateral middle temporal (MT), which is related to the perception of visual motion (Kourtzi & Kanwisher, 2000), and right hippocampus, which is related to emotional processing (McEwen, 1999). Even static pictures of animal stick figures (Zhao et al., 2021), nature, and human content (Di Dio et al., 2016) that depict motion had a higher aesthetic value than static ones and evoke a stronger activation of the cortical motor system and the mirror and mirror-like areas. These previous studies attributed the higher attractiveness of dynamic stimuli (Di Dio et al., 2016; Zhao et al., 2020) to the crucial role of the embodied simulation of actions, emotions, and corporeal sensations in aesthetic judgment (see Freedberg & Gallese, 2007 for a review; but see Caramazza et al., 2014 for a critical review of embodied simulation). This embodied mechanism enables humans to model the inner world of others (see Freedberg & Gallese, 2007 for a review), which may include information about the vitality status (Di Dio et al., 2019).

Although artists have often worked on ways to incorporate the beauty of life into their artworks by portraying bodily actions, little empirical research has provided experimental evidence for the role of vitality behind motion in aesthetics. Therefore, the present study aimed to investigate whether the perceived beauty of vitality contained in motion affects ratings of attractiveness. Here, we are interested in facial attractiveness. This vitality effect on facial attractiveness is possible because of the following two points.

On the one hand, as part of the human body, the face has a specific status because it conveys such a wide variety of information (Langlois et al., 2000), including animacy (Looser et al., 2013). Animacy is a basic perceptual dimension of human faces (Koldewyn et al., 2014). Once we perceive a face, we will process whether it is alive and decide how many social cognitive resources to use in interactions with it (Looser et al., 2013). Pleasantness has been positively correlated with facial animacy (Looser & Wheatley, 2010), and life was found to have a greater aesthetic value than death in faces extracted from paintings (Di Dio et al., 2019). Therefore, when we encounter a face, we may automatically perceive its vitality and adjust our perception of its attractiveness.

On the other hand, researchers have found a positive effect of motion on the attractiveness of faces (Kościński, 2013; Post et al., 2012) and objects (McDowell & Haberman, 2019), which was named as "the frozen effect" (McDowell & Haberman, 2019; Post et al., 2012). Previous studies have found that facial motion influenced facial attractiveness in two ways. On the one hand, facial motion adjusted the structural information related to facial attractiveness, such as symmetry (Hughes & Aung, 2018) and sexual dimorphism (Morrison et al., 2007). On the other hand, facial motion can provide additional nonstructural information to influence judgments of attractiveness, such as emotions (Rubenstein, 2005) and personality (Penton-Voak & Chang, 2008; Roberts et al., 2009). This opens up the possibility for facial motion to increase facial attractiveness by providing additional vitality information.

In the present study, we aimed to investigate whether facial motion increases facial attractiveness through vitality. Accordingly, we manipulated motion and asked participants to rate the vitality and the attractiveness through three experiments to explore the mediating effect of vitality between motion and attractiveness. In Experiment 1, we asked participants to rate the vitality and attractiveness of different types of faces (human, animal, and cartoon faces) in different motions (dynamic, scrambled, and static) in an online questionnaire and found a mediating effect of perceived vitality between motion and perceived attractiveness. In Experiment 2, except to replicate the mediating effect of perceived vitality between motion and perceived attractiveness, we also manipulated facial vitality by vitality priming (high vitality, low vitality, and neutral) to examine its causal effect on the perceived attractiveness of human faces in different motion (dynamic, scrambled, and static). In Experiment 3, except to replicate the mediating effect of perceived vitality between motion and perceived attractiveness on human faces, we also adopted nonface stimuli (animal, inanimate object, and plant) with or without motion (dynamic, static). As different dynamic forms of vitality may also be an influencing factor of perceived vitality, we also manipulated vitality forms (exploding, fading, and pulsing) to explore whether this mediating effect could be generalized to other nonface stimuli and to different vitality forms.

Experiment 1

Method

Participants

Thirty-eight Chinese participants (27 women, 11 men, M_{age} = 22.55, standard deviation [SD_{age}] = 6.02) from the Internet participated in Experiment 1 and were offered monetary compensation. All participants had normal or corrected-to-normal vision and provided informed consent. Power analysis based on Power ANalysis for GEneral Anova designs (PANGEA) (Westfall, 2016), $d = 0.45$, power = .80, var(error) = 0.333, var (Participants × Motion) = 0.167, indicated that 28 participants would be sufficient. The experiments in the present studM_{age} = 22.55y received approval from the Institutional Review Board of our department.

Stimuli

The stimuli were 30 animated Graphics Interchange Format images, generally known as "memes" on the Internet, including three types of commonly used faces (10 real animal faces, 10 cartoon faces, and 10 real human faces). The cartoon faces include SpongeBob SquarePants, Pikachu, and other cartoon animal faces or cartoon human faces. Each picture was manipulated into three motions: dynamic, scrambled, and static. The original animated images were used for the dynamic condition. In the scrambled condition, the frames of each animation were presented in a random order. We chose one frame with a neutral expression from each animation as the static condition to avoid the negative affective response to brief facial variations (Post et al., 2012).

Procedure

Participants completed an online questionnaire. This questionnaire contained two blocks: one for facial attractiveness and the other for facial vitality. The order of the two blocks was counterbalanced across participants. In each block, all 90 pictures were randomly presented. Participants evaluated each picture on a 9-point Likert scale[1] (1 = *very unattractive/no vitality*, 9 = *very attractive/full of vitality*).

Results

Data from two participants were excluded; these participants rated every face's attractiveness at one and nine, respectively, which is an extreme value for each condition. We conducted a 3 (motion: dynamic, scrambled, static) × 3 (face type: animal, cartoon, human) repeated-measures multivariate analysis of variance (MANOVA). Degrees of freedom were adjusted using the Greenhouse–Geisser correction if the assumption of sphericity was violated. All post hoc multiple tests were corrected using the Bonferroni correction.

Facial Attractiveness

The Motion × Face Type interaction did not reach significance, $F(4, 140) = 2.40$, $p = .053$, $\eta_p^2 = .06$. As expected, we found a main effect of motion, $F(2, 70) = 15.36$, $p < .001$, $\eta_p^2 = .31$ (Figure 1a). Post hoc multiple tests revealed that faces in the dynamic condition ($M = 6.00$, $SD = 0.95$) were more attractive than those in the scrambled condition ($M = 5.41$, $SD = 1.18$), $t(35) = 4.36$, $p < .001$, $d = 0.73$, 95% confidence interval (CI) = [0.25, 0.93], and the static condition ($M = 5.32$, $SD = 1.03$), $t(35) = 5.15$, $p < .001$, $d = 0.86$, 95% CI = [0.35, 1.01], but there was no difference between the scrambled and static conditions, $t(35) = 0.65$, $p = 1.00$, $d = 0.11$, 95% CI = [−0.25, 0.42]. There was a main effect of face type, $F(2, 70) = 5.92$, $p = .004$, $\eta_p^2 = .15$. Post hoc multiple tests showed animal faces were more attractive ($M = 5.97$, $SD = 1.30$) than cartoon faces ($M = 5.32$, $SD = 1.02$), $t(35) = 3.13$, $p = .011$, $d = 0.52$, 95% CI = [0.13, 1.17], and human faces ($M = 5.44$, $SD = 1.19$), $t(35) = 2.89$, $p = .020$, $d = 0.48$, 95% CI = [0.07, 0.99], while cartoon faces were the same as human faces, $t(35) = -0.57$, $p = 1.000$, $d = 0.10$, 95% CI = [−0.65, 0.41].

Facial Vitality

The results for facial vitality were similar to those for facial attractiveness. The Motion × Face Type interaction did not reach significance, $F(4, 140) = 2.25$, $p = .067$, $\eta_p^2 = .06$. As expected, there was a main effect of motion, $F(2, 70) = 24.14$, $p < .001$, $\eta_p^2 = .41$ (Figure 1b). Post hoc multiple tests revealed that faces in the dynamic condition ($M = 6.71$, $SD = 1.00$) had higher vitality than those in the scrambled condition ($M = 6.13$, $SD = 1.49$), $t(35) = 3.19$, $p = .009$, $d = 0.53$, 95% CI = [0.12, 1.03], and the static condition ($M = 5.39$, $SD = 1.11$), $t(35) = 7.50$, $p < .001$, $d = 1.25$, 95% CI = [0.88, 1.77]. Additionally, the scrambled condition had higher vitality than the static condition, $t(35) = 3.50$, $p = .004$, $d = 0.58$, 95% CI = [0.21, 1.28]. There was a main effect of face type, $F(1.71, 59.69) = 16.37$, $p < .001$, $\eta_p^2 = .32$. Post hoc multiple tests showed higher vitality for animal faces ($M = 6.38$, $SD = 1.17$), $t(35) = 5.12$, $p < .001$, $d = 0.85$, 95% CI = [0.45, 1.32], and human faces ($M = 6.36$, $SD = 1.35$), $t(35) = 4.18$, $p = .001$, $d = 0.70$, 95% CI = [0.35, 1.40], compared to cartoon faces ($M = 5.49$, $SD = 1.04$), while there was no difference between animal and human faces, $t(35) = 0.09$, $p = 1.000$, $d = 0.01$, 95% CI = [−0.35, 0.38].

Mediation Effect

We conducted mediation analysis using Mplus software, with motion as the independent variable, facial attractiveness as the dependent variable, and facial vitality as the mediator. Because there was no Motion × Face Type interaction, we only added face type as a control variable for facial attractiveness and vitality. All variables were nested within individuals. The independent variable was multicategorical, so referring to the mediation analysis in Hayes and Preacher (2014), we used indicator coding to represent motion and treated the static condition as the reference category. We calculated the relative indirect/direct/total effect of the dynamic/scrambled condition, which indicated the indirect/direct/total effect on the facial attractiveness of being in the dynamic/scrambled condition relative to the static condition.

The results of the mediation analysis with standardized coefficients are shown in Figure 2. Facial vitality was positively related to facial attractiveness ($\beta = .70$, standard error [SE] = 0.04, $t = 19.99$, $p < .001$). For dynamic condition, the relative total effect was significantly positive ($\beta = .24$, $SE = 0.06$, $t = 4.00$, $p < .001$), the relative indirect effect via facial vitality was also significantly positive ($\beta = .29$, $SE = 0.04$, $t = 6.77$, $p < .001$), while the relative direct effect was not significant ($\beta = -0.05$, $SE = 0.05$, $t = -0.94$, $p = .346$). These results indicated that dynamic condition was more attractive than static condition, due to the positive mediating effect of vitality. For scrambled condition, the relative total effect was not significant ($\beta = .03$, $SE = 0.06$, $t = 0.49$, $p = .622$), but the relative indirect effect via facial vitality was significantly positive ($\beta = .16$, $SE = 0.04$, $t = 3.87$, $p < .001$) and the relative direct effect was significantly negative ($\beta = -0.13$, $SE = 0.05$, $t = -2.79$, $p = .005$). This indicated the suppression effect that opposite indirect and direct effects lead to an insignificant total effect (MacKinnon et al., 2000; Wen & Ye, 2014). Therefore, there was no difference between the attractiveness of scrambled condition and that of static condition because of the positive mediating effect of vitality and the negative direct effect caused by factors other than vitality.

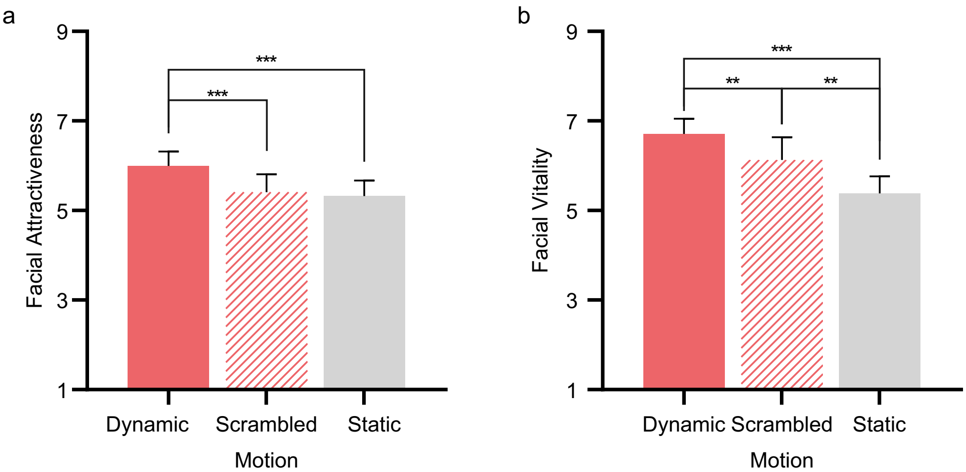
Discussion

As expected, we replicated "the frozen effect" (Post et al., 2012), in which dynamic faces are more attractive than static faces. We also observed a positive mediating effect of vitality

[1] 1 = 非常没有吸引力/非常没有生命力, 9 = 非常具有吸引力/非常具有生命力。Vitality is translated into the Chinese word "生命力" (Kleeman & Yu, 2010). In the Chinese dictionary, "生命力" refers to the ability of things to survive and develop. 生命力shēng mìng lì: 指事物具有的生存、发展的能力 (Chinese Academy of Social Sciences Institute of Linguistics, 2016).

Figure 1

(a) Mean Facial Attractiveness and (b) Mean Facial Vitality of Each Motion in Experiment 1

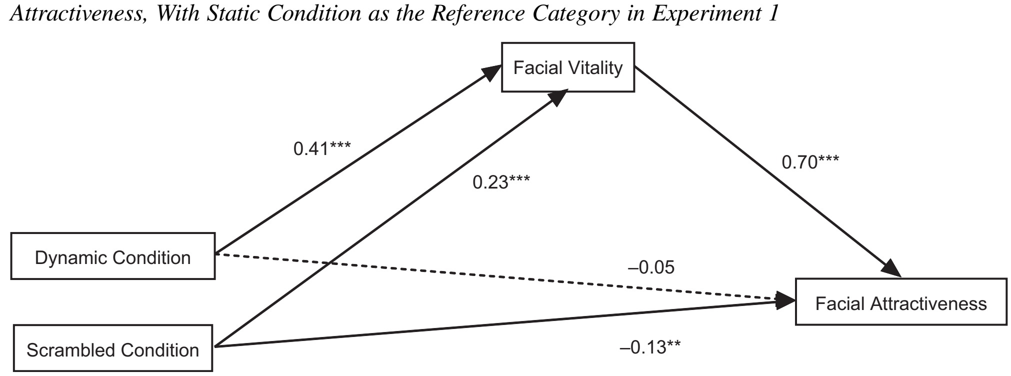


Note. Error bars represent 95% confidence intervals. See the online article for the color version of this figure.
** $p < .01$. *** $p < .001$.

between facial motion and facial attractiveness. However, there was no total effect in the scrambled condition. We reasoned that while facial motion increased facial attractiveness through facial vitality, scrambled motion decreased facial attractiveness through other factors, as shown by the negative direct effect between the scrambled condition and facial attractiveness. Post et al. (2012) suggested that dynamic faces were more attractive than static faces only when facial motion was continuous, as these dynamic faces were easier to recognize. Processing fluency affects aesthetic experience (Reber, Schwarz, & Winkielman, 2004). The scrambled condition may increase attractiveness through high vitality on the one hand and decrease attractiveness through low processing fluency on the other. As the differences in objective processing fluency between the dynamic and scrambled conditions are difficult to eliminate, we measured participants' subjective processing fluency and added both vitality and subjective processing fluency as a mediator in the mediation analysis in Experiment 2. Subjective processing fluency can be felt and reported and is an important determinant of liking (Forster et al., 2013, 2015). The stimuli that are objectively easier to process also have higher subjective processing fluency (Forster et al., 2013; Reber, Wurtz, & Zimmermann, 2004). Subjective experience represents objective processes in a highly condensed form, including processing fluency (Reber, Wurtz, & Zimmermann, 2004). To test the causal effect of facial vitality on facial attractiveness, we manipulated vitality through priming by showing participants a set of high- versus low-vitality words that describe the person in the following face image. Since animal, cartoon, and human faces showed similar results in Experiment 1, we only used human faces in Experiment 2.

Figure 2

Facial Vitality Mediated the Relationship Between Motion (Dynamic, Scrambled, Static) and Facial Attractiveness, With Static Condition as the Reference Category in Experiment 1



Note. The figure omits face type, which was treated as the control variable on both facial attractiveness and facial vitality. All the coefficients are standardized. Nonsignificant paths are marked by dotted lines. $R^2 = .49$ for facial attractiveness.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Experiment 2

Method

Participants

Thirty university students (15 women, 15 men; $M_{age} = 19.93$, $SD_{age} = 2.50$) participated in the study and were offered monetary compensation. All participants had normal or corrected-to-normal vision and provided informed consent prior to the experiment. With a medium effect size, power analysis based on PANGEA (Westfall, 2016), $d = 0.45$, power = .80, var (error) = 0.333, var (Participants × Motion × Vitality Priming) = 0.083, indicated that 16 participants would be sufficient.

Apparatus and Stimuli

We obtained 30 frontal animated faces (15 female and 15 male) from social networks and modified each animated face into three motions. We extracted 2 s from each video to create the dynamic faces (300 × 400 pixels, 30 frames per second). We played the 60 frames of each extracted video clip in a random order for the scrambled face condition. Finally, the frame with the smallest facial distortion relative to a neutral expression was selected from each video clip as the static face.

In a pretest, 47 participants rated the vitality of 18 Chinese idioms/phrases relating to human vitality on a 9-point scale (1 = *no vitality*, 9 = *full of vitality*). We then selected five high-vitality idioms/phrases ($M = 7.75$, $SD = 0.67$) and five low-vitality idioms/phrases ($M = 2.84$, $SD = 0.79$) for vitality priming. There was a significant difference in vitality between the groups, $F(1, 46) = 713.76$, $p < .001$, $\eta_p^2 = .94$. Five pairs of neutral furniture words were used in the neutral priming condition. The Chinese words used for high-vitality, low-vitality, and neutral labels and their corresponding English translations are shown in Table A1 in the Appendix. We combined three related words as word groups and traversed all combinations, obtaining a total of 10 different word groups for each high-vitality, low-vitality, and neutral priming conditions. All stimuli were presented against a black background on a 23-in. monitor with a resolution of 1,920 × 1,080 pixels. The experiment was conducted using MATLAB.

Procedure

The participants completed two blocks: the first block for facial attractiveness and the second for facial vitality. The block order was fixed to ensure that the mediating effect of facial vitality was not due to previous vitality judgments affecting attractiveness judgments. There were 90 faces in each block, comprising 30 faces for each motion. All 90 faces were presented randomly. In each trial, the vitality of the target face was primed by three vitality words from one of the word groups. The thirty faces were randomly divided into three groups, each containing five female and five male faces. Each group of faces was paired with one type of vitality priming (high, low, or neutral), and the pairings were counterbalanced between subjects. Each face in a face group was randomly paired with one word group, so we had 10 faces paired with 10 words groups of a certain type of vitality priming. The pairing was fixed for each participant.

In each trial (Figure 3), participants first saw a fixation cross in the center of the screen for 300 ms, and then an instruction ("this person is always" for the high-/low-vitality priming and "the room has" for the neutral priming) was presented in the center of the screen for 500 ms. This procedure was then repeated for the three priming words. After priming, a fixation cross was presented for 500 ms, and then a face appeared in the center of the screen for 2 s. After the face disappeared, the center of the screen displayed a 9-point Likert scale (1 = *very unattractive/no vitality*, 9 = *very attractive/full of vitality*) until the participant responded.

The third block was to measure participants' subjective processing fluency. This block was similar to the previous two blocks except that there was no priming; participants' task was to rate how easy it was to process the face on a 9-point Likert scale[2] (1 = *very difficult*, 9 = *very easy*).

Results

We conducted a 3 (motion: dynamic, scrambled, static) × 3 (vitality priming: high-/low-vitality, neutral) repeated-measures MANOVA on facial attractiveness and facial vitality. Degrees of freedom were adjusted using the Greenhouse–Geisser correction if the assumption of sphericity was violated. All post hoc multiple tests were corrected using the Bonferroni correction.

Facial Vitality

Because we manipulated vitality, these results were also used for the manipulation checks. There was a main effect of vitality priming, $F(1.40, 40.63) = 15.60$, $p < .001$, $\eta_p^2 = .35$ (Figure 4a). As expected, faces primed with high-vitality words ($M = 5.98$, $SD = 0.97$) had higher vitality ratings than those primed with low-vitality words ($M = 4.99$, $SD = 0.99$), $t(29) = 3.96$, $p = .001$, $d = 0.72$, 95% CI = [0.35, 1.61]. Faces primed with low-vitality words had lower vitality ratings than those primed with neutral words, $t(29) = -5.38$, $p < .001$, $d = 0.98$, 95% CI = [−1.29, −0.46]. However, faces primed with high-vitality words had no difference from those primed with neutral words ($M = 5.87$, $SD = 0.77$), $t(29) = 0.69$, $p = 1.000$, $d = 0.13$, 95% CI = [−0.29, 0.50]. Hence, the manipulation was partially successful.

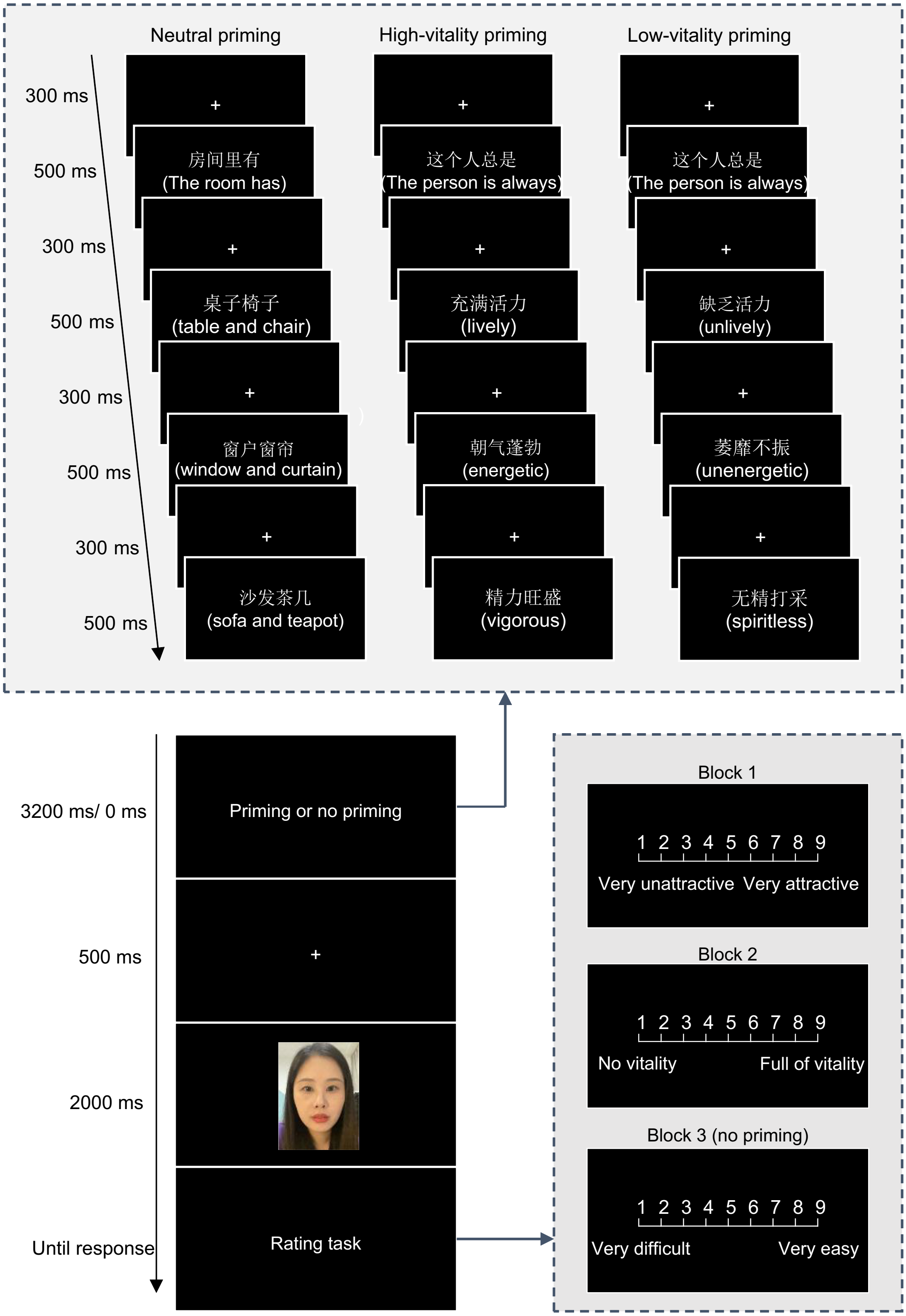
We found a main effect of motion, $F(1.24, 35.82) = 42.62$, $p < .001$, $\eta_p^2 = .60$ (Figure 4b). Post hoc multiple tests revealed that the vitality ratings of faces in the dynamic condition ($M = 5.70$, $SD = 0.76$) were higher than in the static condition ($M = 5.00$, $SD = 0.78$), $t(29) = 8.22$, $p < .001$, $d = 1.50$, 95% CI = [0.48, 0.92]. Faces in the scrambled condition ($M = 6.13$, $SD = 0.82$) had higher vitality ratings than those in the dynamic condition, $t(29) = 4.01$, $p = .001$, $d = 0.73$, 95% CI = [0.16, 0.70], and the static condition, $t(29) = 6.87$, $p < .001$, $d = 1.25$, 95% CI = [0.71, 1.55]. There was no interaction between motion and vitality priming, $F(4, 116) = 0.33$, $p = .859$, $\eta_p^2 = .01$.

Facial Attractiveness

There was a main effect of vitality priming, $F(1.62, 46.88) = 11.38$, $p < .001$, $\eta_p^2 = .28$ (Figure 4c). Post hoc multiple tests showed results similar to those for facial vitality. Faces primed

[2] 1 = 非常困难，9 = 非常容易

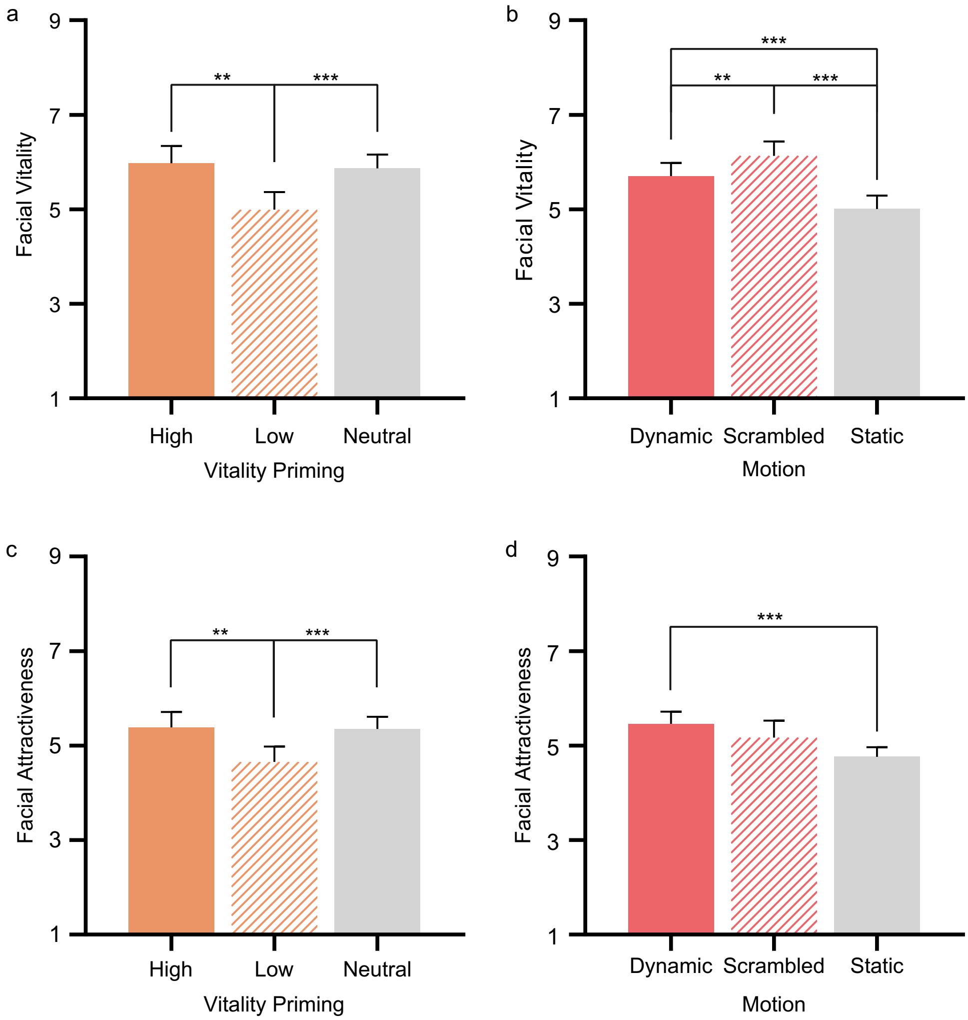
Figure 3
The Trial Procedure of Experiment 2



Note. The order of blocks was fixed; block 3 had no priming. All instructions were in Chinese. The face depicted here was not used as a stimulus in the experiment. See the online article for the color version of this figure.

Figure 4

Mean Facial Vitality for Each (a) Vitality Priming and (b) Motion; Mean Facial Attractiveness for Each (c) Vitality Priming and (d) Motion in Experiment 2



Note. Error bars represent 95% confidence intervals. See the online article for the color version of this figure.
** $p < .01$. *** $p < .001$.

with high-vitality words ($M = 5.39$, $SD = 0.86$) were rated as more attractive than those primed with low-vitality words ($M = 4.65$, $SD = 0.88$), $t(29) = 3.55$, $p = .004$, $d = 0.65$, 95%CI = [0.21, 1.26]. Faces primed with low-vitality words were less attractive than those primed with neutral words, $t(29) = -4.03$, $p = .001$, $d = 0.74$, 95% CI = [−1.14, −0.26]. There was no difference between high-vitality priming and neutral priming ($M = 5.35$, $SD = 0.70$), $t(29) = 0.29$, $p = 1.000$, $d = 0.05$, 95%CI = [−0.30, 0.38].

There was a main effect of motion, $F(1.61, 46.62) = 12.17$, $p < .001$, $\eta_p^2 = .30$ (Figure 4d). Post hoc multiple tests revealed that faces in the dynamic condition ($M = 5.46$, $SD = 0.69$) were more attractive than those in the static condition ($M = 4.76$, $SD = 0.55$), $t(29) = 5.98$, $p < .001$, $d = 1.09$, 95% CI = [0.40, 0.99], but there was no difference between the dynamic and scrambled conditions ($M = 5.17$, $SD = 0.97$), $t(29) = 2.25$, $p = .096$, $d = 0.41$, 95% CI = [−0.04, 0.62], as well as between the scrambled and static conditions, $t(29) = 2.34$, $p = .080$, $d = 0.43$, 95% CI = [−0.04, 0.84]. There was no interaction between motion and vitality priming, $F(4, 116) = 1.62$, $p = .175$, $\eta_p^2 = .05$.

Subjective Processing Fluency

We also conducted a one-way repeated-measures analysis of variance with motion and subjective processing fluency as the independent and dependent variables, respectively. There was a main effect of motion, $F(1.23, 35.65) = 65.98$, $p < .001$, $\eta_p^2 = .70$. Post hoc multiple tests revealed similar subjective processing fluency for dynamic faces ($M = 7.44$, $SD = 1.09$) and static faces ($M = 7.86$, $SD = 1.37$), $t(29) = -2.37$, $p = .075$, $d = 0.43$, 95% CI = [−0.87, 0.03]. Both had higher subjective processing fluency than scrambled faces ($M = 4.50$, $SD = 1.68$); for dynamic faces: $t(29) = 9.15$,

$p < .001$, $d = 1.67$, 95% CI = [2.13, 3.77], and static faces: $t(29) = 8.14$, $p < .001$, $d = 1.49$, 95% CI = [2.31, 4.42].

Mediating Effect

We conducted a mediation analysis using Mplus software, with motion as the independent variable, facial attractiveness as the dependent variable, facial vitality and subjective processing fluency as the mediators, and vitality priming as the control variable for both facial attractiveness and facial vitality. All variables were nested within individuals. We used indicator coding to represent motion and treated the static condition as the reference category. The results of the mediation analysis with standardized coefficients are shown in Figure 5. Facial vitality was positively related to facial attractiveness ($\beta = .65$, $SE = 0.05$, $t = 14.49$, $p < .001$). For the dynamic condition, the relative total effect was significantly positive ($\beta = .31$, $SE = 0.06$, $t = 5.08$, $p < .001$), the relative indirect effect on facial attractiveness via facial vitality was significantly positive ($\beta = .18$, $SE = 0.04$, $t = 4.58$, $p < .001$), and the relative direct effect was also significantly positive ($\beta = .13$, $SE = 0.05$, $t = 2.33$, $p = .020$). For the scrambled condition, the relative total effect was significantly positive ($\beta = .18$, $SE = 0.06$, $t = 2.88$, $p = .004$), the relative indirect effect on facial attractiveness via facial vitality was significantly positive ($\beta = .29$, $SE = 0.04$, $t = 6.68$, $p < .001$), while the relative direct effect was significantly negative ($\beta = -0.18$, $SE = 0.08$, $t = -2.33$, $p = .020$). However, the relative indirect effect of motion on facial attractiveness via processing fluency was not significant (dynamic condition: $\beta = .01$, $SE = 0.01$, $t = 1.16$, $p = .246$; scrambled condition: $\beta = .07$, $SE = 0.05$, $t = 1.41$, $p = .160$). These results indicated that the dynamic and scrambled conditions were more attractive than the static condition, due to the positive mediating effect of vitality rather than subjective processing fluency.

Discussion

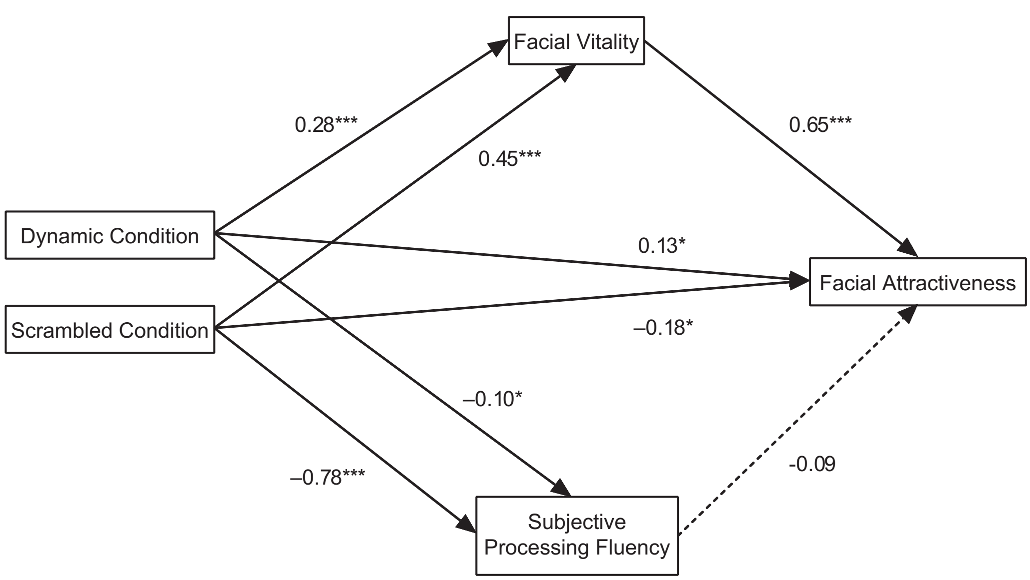
In Experiment 2, faces primed with high-vitality words received higher vitality and attractiveness ratings than those primed with low-vitality words, which indicated that vitality priming effectively influenced ratings of facial vitality and attractiveness. There was no difference between high-vitality and neutral priming, probably because the faces we found on the social network were usually presented in a high vitality state, so high-vitality priming did not add additional useful information.

Consistent with Experiment 1, dynamic faces had higher vitality and attractiveness than static faces. There is no interaction between motion and vitality priming. As vitality priming provided vitality information of the face, this nonsignificant interaction indicated that motion could enhance the perceived vitality and attractiveness, unaffected by the original vitality information of the face primed by vitality labels.

Again, vitality mediated the relationship between facial motion and facial attractiveness, which indicated that the higher attractiveness of the dynamic condition was due to its higher vitality. The relative direct effect between the scrambled condition and facial attractiveness was still negative even when we controlled for subjective processing fluency in Experiment 2, indicating that subjective processing fluency could not account for the negative direct effect between the scrambled condition and facial attractiveness in Experiments 1 and 2. This is inconsistent with

Figure 5

Facial Vitality Mediated the Relationship Between Motion (Dynamic, Scrambled, Static) and Facial Attractiveness, With the Static Condition as the Reference Category in Experiment 2



Note. The figure omits priming labels, which were treated as the control variable for both facial attractiveness and facial vitality. All the coefficients are standardized. Nonsignificant paths are marked by dotted lines. $R^2 = 0.48$ for facial attractiveness. Model fit index: $\chi^2(3) = 6.07$, $p = .108$, comparative fit index = 0.99, Tucker-Lewis index = 0.97, root-mean-square error of approximation = 0.06, standardized root mean square residual = 0.02.
* $p < .05$. *** $p < .001$.

the fact that prototype faces are more attractive because they are easier to process (Winkielman et al., 2006). Probably because although subjective processing fluency is related to objective processing fluency, it is not a one-to-one mapping (Forster et al., 2013; Reber, Wurtz, & Zimmermann, 2004). Therefore, we cannot completely rule out the role of objective processing fluency. Future research can further explore its role by using participants' categorization speed or facial electromyography as the indicator of processing fluency as by Winkielman et al. (2006). In addition, we speculated that the reduced attractiveness of scrambled faces was due to their lower predictability or naturalness, as previous research has identified that the more predictable (McDowell & Haberman, 2019) or natural (Chamberlain et al., 2022) the motion of a dynamic stimulus is, the stronger participants' preference for it.

As discussed above, in Experiments 1 and 2, we consistently found higher attractiveness ratings for dynamic (vs. static) faces. Nevertheless, the results regarding the scrambled faces were inconsistent between the two experiments. The vitality of scrambled faces was in between dynamic and static faces in Experiment 1, while it was higher than both dynamic and static faces in Experiment 2. The attractiveness of scrambled faces was similar to that of static faces and lower than that of dynamic faces in Experiment 1, while it had no significant difference with that of dynamic and static faces in Experiment 2. Post et al. (2012) showed higher attractiveness for dynamic video than frame-scrambled video. These results indicated the results of scrambled faces are not stable, in line with the unstable results of scrambled faces (vs. dynamic/static faces) in holistic face processing (e.g., Zhou et al., 2021). Therefore, to reduce the number of conditions, we only adopted dynamic and static motions in Experiment 3.

Experiment 3

In Experiment 3, we adopted both human faces and nonface stimuli (animal, inanimate object, and plant) to explore whether the mediating effect of vitality was limited to human faces. As vitality forms affect the perception of the internal state of an agent (Di Cesare et al., 2014, 2015; see Di Cesare et al., 2020 for a review), we also adopted different vitality forms (exploding, fading, and pulsing) to explore whether observers' perceived vitality varied by different vitality forms and whether the mediating effect of vitality remains under different vitality forms. These vitality forms were described by Stern (2010) and can be shown by the intensity (force) change over time: exploding reflected intensity increases over time, fading reflected intensity decreases over time, and pulsing reflected intensity fluctuates slightly over time.

Method

Participants

Thirty-six participants (18 women and 18 men, $M_{age} = 20.36$, $SD_{age} = 1.07$) from the Internet participated in this experiment and provided informed consent. With a medium effect size, power analysis based on PANGEA (Westfall, 2016), $d = 0.45$, power = .80, var (error) = 0.20, var (Participants × Motion × Stimulus Category × Vitality Forms) = 0.04, indicated that eight participants would be sufficient.

Apparatus and Stimuli

The stimuli were 32 videos from the Internet representing four stimulus categories: animal, human, inanimate object, and plant. Inanimate objects include flags, waves, etc. Each video was processed into three 5 s dynamic video clips (400 × 300 pixels, 25 frames per second), which had different vitality forms: exploding, fading, and pulsing (see Table 1 for examples). In order to avoid different degrees of intensity, the video clips in the fading condition were the reversed versions of those in the exploding condition. We then chose the last frame of each video clip as the static stimulus (see Table 1 for examples). As the last frame was taken from a low intensity state (e.g., bud) in the fading condition, while from a high intensity state (e.g., bloom) in the exploding condition, so the static condition of different vitality forms may also vary in vitality. Because human faces looked unnatural in some video frames, we selected the most natural frame among the last few frames as the static stimuli for the human category. Finally, 96 dynamic video clips and 96 static frames were created, which were presented against a dark background on a computer with a 23-in. monitor at 1,920 × 1,080 resolution. The experiment was run online using E-prime 2.0.

Procedure

The participants rated the attractiveness and vitality of the stimuli in two separate blocks. The order of the two blocks was counterbalanced across participants. In each block, all 96 video clips and 96 static frames were presented in a random order. In each trial, participants first saw a fixation cross in the center of the screen for 500 ms, which was then replaced by a video clip or static frame. After 5 s, the stimulus disappeared, and the center of the screen displayed a 9-point Likert scale (1 = *very unattractive/no vitality*, 9 = *very attractive/full of vitality*). The participants' task was to rate the attractiveness and vitality of the stimulus in the presented video or frame. After completing the rating task, participants responded to a question asking whether they had ever seen the stimuli before the experiment.

Results

We excluded four participants who had viewed more than a quarter of the videos before. We conducted a 2 (motion: dynamic, static) × 4 (stimulus category: animal, human, inanimate object, plant) × 3 (vitality forms: exploding, fading, pulsing) repeated-measures MANOVA on attractiveness and vitality. Degrees of freedom were adjusted using the Greenhouse–Geisser correction if the assumption of sphericity was violated. All post hoc multiple tests were corrected using the Bonferroni correction. We also conducted analysis using the score-difference between dynamic and static as the dependent variable (see Supplemental materials).

Attractiveness

We found a significant interaction between Motion × Stimulus Category × Vitality Forms, $F(4.53, 140.31) = 3.47$, $p = .007$, $\eta_p^2 = .10$ (see Figure 6a and 6b). Post hoc multiple tests revealed that the dynamic condition was more attractive than the static condition for each stimulus category and vitality forms, $ps < .001$.

Table 1
Examples of Three Vitality Forms for Each Stimulus Category in the Static (Bold) and Dynamic Conditions

Stimulus	Exploding	Fading	Pulsing
Animal	Asleep → **Awake**	Awake → **Asleep**	**Awake**
Human	Stopping → **Talking/singing/dancing**	Talking/singing/dancing → **Stopping**	**Talking/singing/dancing**
Inanimate object	Still → **Fluttering**	Fluttering → **Still**	**Fluttering**
Plant	Bud → **Bloom**	Bloom → **Bud**	**Swinging flowers**

We also conducted the simple effect analysis for each motion and found a significant interactive effect between stimulus category and vitality forms for both dynamic, $F(2.91,\ 90.29) = 5.82$, $p = .001$, $\eta_p^2 = .16$, and static condition, $F(3.08,\ 95.60) = 3.15$, $p = .028$, $\eta_p^2 = .09$. For the dynamic condition (see Figure 6a), we only found significant difference between the exploding ($M = 5.88$, $SD = 1.48$) and fading condition ($M = 4.97$, $SD = 1.40$), $t(31) = 3.52$, $p = .004$, $d = 0.62$, 95% CI = [0.26,1.57], and between the exploding and pulsing condition ($M = 5.28$, $SD = 1.49$), $t(31) = 5.05$, $p < .001$, $d = 0.89$, 95% CI = [0.30, 0.90], for plants. There was no other significant difference between any two vitality forms, $ps > .103$. For the static condition (see Figure 6b), we only found a significant difference between the exploding ($M = 4.33$, $SD = 1.47$) and fading condition ($M = 3.87$, $SD = 1.27$) for plants, $t(31) = 2.64$, $p = .039$, $d = 0.47$, 95% CI = [0.02, 0.90]. There was no other significant difference between any two vitality forms, $ps > .113$.

Vitality

We found a significant interaction between Motion × Stimulus Category × Vitality Forms, $F(4.02,\ 124.72) = 6.76$, $p < .001$, $\eta_p^2 = .18$ (see Figure 6c and 6d). Post hoc multiple tests revealed that the dynamic condition was more attractive than static for each stimulus category and vitality forms, $ps < .001$.

We also conducted the simple effect analysis for each motion and found a significant interactive effect between stimulus category and vitality forms for both dynamic, $F(2.24,\ 69.28) = 14.57$, $p < .001$, $\eta_p^2 = .32$, and static condition, $F(4.30,\ 133.36) = 6.48$, $p < .001$, $\eta_p^2 = .17$. For the dynamic condition (see Figure 6c), the exploding and pulsing condition had higher vitality than the fading condition for animals and plants, $ps < .009$. The exploding condition had no difference with the pulsing condition for animals, $t(31) = -2.47$, $p = .058$, $d = 0.44$, 95% CI = [−0.67, 0.01], but had higher vitality than the pulsing condition for plants, $t(31) = 5.82$, $p < .001$, $d = 1.05$, 95% CI = [0.46, 1.18]. There was no other significant difference between any two vitality forms, $ps > .153$. For the static condition (see Figure 6d), the exploding condition had higher vitality than the fading condition for each stimuli category, $ps < .011$. The pulsing condition had higher vitality than the fading condition for animals and plants, $ps < .001$. There was no other significant difference between any two vitality forms, $ps > .096$.

Mediating Effect

Mediation analysis was conducted using Mplus software, with motion as the independent variable (static = 0, dynamic = 1), attractiveness as the dependent variable, and vitality as the mediator for each stimulus category in each vitality forms. The results showed that vitality positively mediated the relationship between motion and attractiveness, and this mediation effect was significant regardless of stimulus category and vitality forms (Table 2).

Discussion

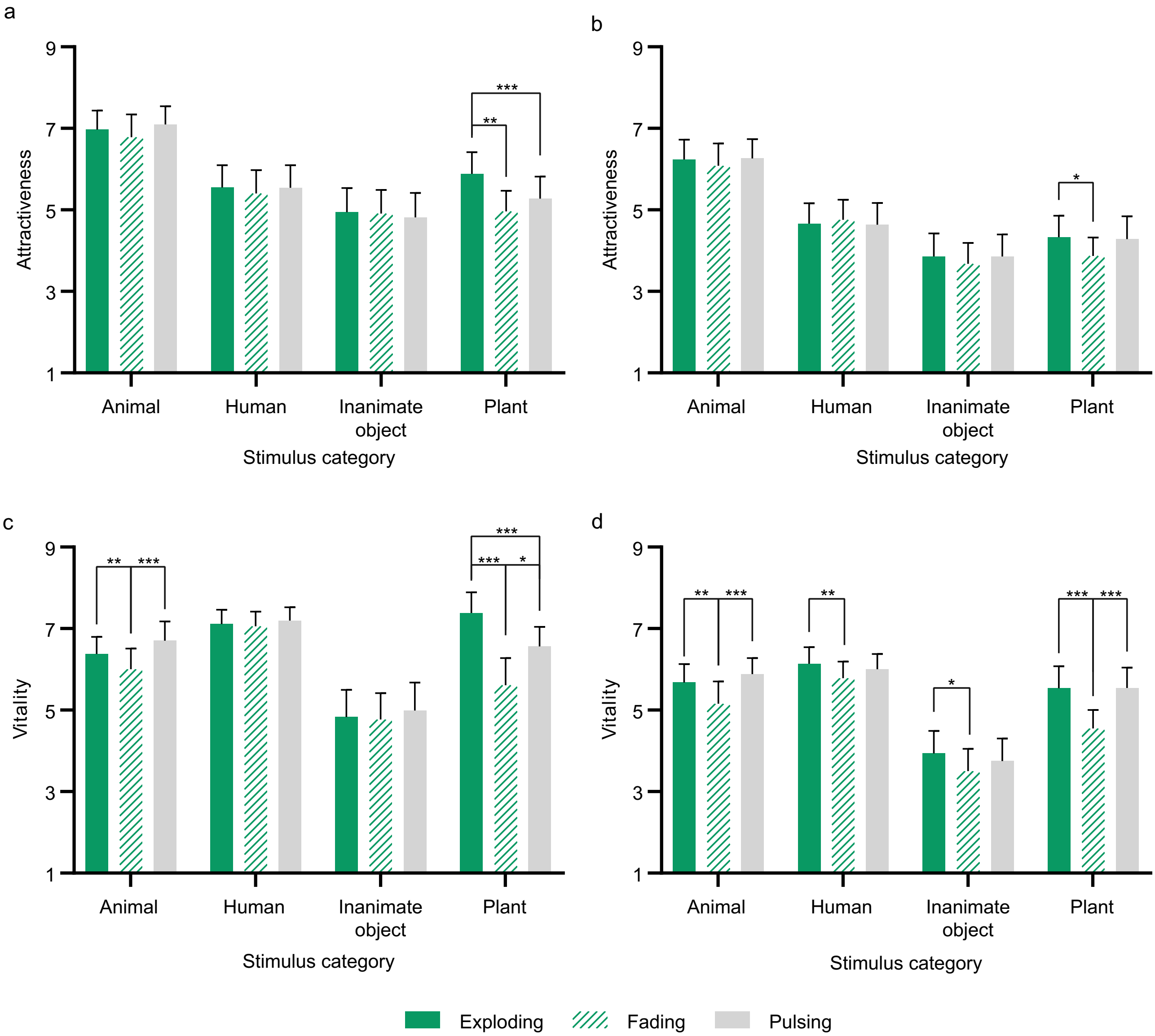
Consistent with Experiments 1 and 2, Experiment 3 showed that dynamic stimuli had higher attractiveness and vitality ratings than static stimuli, and vitality had a mediating effect between motion and attractiveness, regardless of stimulus categories and vitality forms. Although the indirect effect was only marginally significant for humans in the pulsing condition, the trend was the same.

Interestingly, we found an interaction between motion, stimulus category, and vitality forms on vitality. For the dynamic condition, the exploding condition had higher vitality than the fading condition for animals and plants. Although the frames of their exploding and fading conditions were the same, the reversed sequences revealed different ways of intensity change for each stimulus (Table 1). People perceive the internal state of the agent from vitality forms, and a gentle action may lead to a more positive affection experience than a rude action (Di Cesare et al., 2014, 2015; see Di Cesare et al., 2020 for a review). Similarly, the increasing and decreasing intensities may make the observer perceive different internal states of the stimulus, and the exploding condition may bring higher energy, enthusiasm, and spirit. We only found this difference in animals and plants, probably because the intensity change of animals (between awake and asleep) and plants (between bloom and bud) may be greater than that of humans (between acting and stopping) and inanimate objects (between moving and still). Experiment 3 provided evidence that when the intensity change is large enough, people are able to perceive different vitality from different vitality forms, even if the image information is the same for each frame.

For the static condition, the exploding condition had higher vitality than the fading condition for all stimulus categories. This is probably because the last frame was taken from a low intensity state in the fading condition, but from a high intensity state in the exploding condition. Our results were consistent with previous research that showed static pictures of animal stick figures (Zhao et al., 2021), nature, and human content (Di Dio et al., 2016) that depict motion had higher aesthetic value than static ones and generalized this effect to different stimulus categories. As static pictures of that depict motion could evoke a stronger activation of the cortical motor system (Di Dio et al., 2016; Zhao et al., 2021), mirror and mirror-like areas (Di Dio et al., 2016), the last frame in the exploding condition with high intensity in the present experiment may also have activated the participants' motor areas, leading to higher motion resonance.

Figure 6

Attractiveness Rating of (a) Dynamic and (b) Static Condition; Vitality Rating of (c) Dynamic and (d) Static Condition in Experiment 3



Note. Error bars represent 95% confidence intervals. Dynamic condition had significantly higher attractiveness and vitality than static condition for each stimulus category and vitality forms, *ps* < .001. See the online article for the color version of this figure.
* $p < .05$. ** $p < .01$. *** $p < .001$.

General Discussion

Across three experiments, we found that dynamic faces received higher vitality and attractiveness ratings than static faces, and vitality positively mediated the relationship between motion and attractiveness. We verified the causal effect of facial vitality on facial attractiveness using vitality priming in Experiment 2 and extended the mediating effect of vitality to other stimulus categories and vitality forms in Experiment 3.

On the one hand, our results support our hypothesis that motion increases perceptions of vitality. Vitality is the manifestation of life (Stern, 2010) and a specific psychological experience of possessing enthusiasm and spirit (Bostic et al., 2000; Ryan & Frederick, 1997). Its forms are dynamic (Di Cesare et al., 2014, 2015; see Di Cesare et al., 2020 for a review; Stern, 2010). This also pertains to faces. Dynamic faces had higher vitality than static faces. It is consistent with the finding that biological motion reflects animacy (Chang & Troje, 2008). In addition, our results in Experiment 3 reflected that people also perceived vitality from the motion of inanimate objects, just as they recognized moving circles (Szego & Rutherford, 2007) and chasing discs (Frankenhuis et al., 2013) as lifelike objects. This vitality stems from the internal energy source implied by motion (Rosa-Salva et al., 2016; Stewart, 1982).

Table 2

Indirect Effect of Motion on Attractiveness via Vitality for Each Stimulus Category in Each Vitality Forms in Experiment 3

Stimulus category	Vitality forms	Indirect effect	*SE*	*t*	*p*
Animal	Exploding	0.19	0.08	2.35	.019
	Fading	0.22	0.09	2.38	.017
	Pulsing	0.24	0.09	2.84	.005
Human	Exploding	0.15	0.06	2.36	.019
	Fading	0.15	0.08	2.01	.045
	Pulsing	0.14	0.08	1.91	.057
Inanimate object	Exploding	0.27	0.07	3.68	<.001
	Fading	0.28	0.09	3.27	.001
	Pulsing	0.29	0.10	3.00	.003
Plant	Exploding	0.27	0.07	3.68	<.001
	Fading	0.16	0.06	2.52	.012
	Pulsing	0.20	0.07	2.81	.005

Note. All the coefficients are standardized. *SE* = Standard error.

It should be noted that vitality is affected by dynamism but is not equal to perceptual dynamism. Vitality refers to animation and the ability to survive and develop (Oxford University Press, n.d.), while dynamics refers to how much movement is (Di Dio et al., 2016). Although movements with different time, force(s), space, and intention are the forms of vitality and affect the perception of vitality (Stern, 2010), vitality is not just the perceptual dynamism that is reflected by different time, force(s), and space, but a deeper referenced subjective experience (Stern, 2010) or psychological experience (Bostic et al., 2000; Ryan & Frederick, 1997) of an inner state according to these physical movement cues and intention reference. First, this was evidenced by the effect of vitality priming in Experiment 2, where there is no physical movement at all. The second evidence is the effect of vitality forms in animals and plants in Experiment 3, where exploding (dynamic animal: Asleep → Awake; dynamic plant: Bud → Bloom; static animal: awake; static plant: bloom) received larger vitality ratings than fading (dynamic animal: Awake → Asleep; dynamic plant: Bloom → Bud; static animal: asleep; static plant: bud) for both dynamic condition where movement is similar and for static condition where no motion was depicted.

On the other hand, we found a positive effect of vitality on facial attractiveness, consistent with the higher aesthetic value of life than death that was identified in the context of artworks (Di Dio et al., 2019). One possible explanation is that higher vitality reflects greater energy and the ability to thrive, and humans prefer healthy individuals (Thornhill & Gangestad, 1993). However, this cannot be the whole reason, because the effect of vitality on aesthetic judgment was also exerted on inanimate objects without health properties.

Hence, an alternative explanation is the embodied simulation of aesthetic experience (see Freedberg & Gallese, 2007). Our bodies and minds may resonate with the motion of both living beings (Di Dio et al., 2016; Zhao et al., 2021) and nature scene (Di Dio et al., 2016; Zhao et al., 2020), and this motion resonance is related to vitality information (Di Dio et al., 2019) and aesthetic experience (Di Dio et al., 2019; Zhao et al., 2020; for a review, see Freedberg & Gallese, 2007). We propose the concept "vitality contagion" to refer to this process, just as researchers (e.g., Hatfield et al., 1993) used the concept "emotional contagion" to refer to the phenomenon that people imitate others' behavior to converge emotionally. That is, when people observe a thing with high vitality, they may also generate this embodied simulation to converge on vitality, causing vitality contagion. As subjective vitality is positively correlated with well-being (Ryan & Frederick, 1997), this vitality contagion is likely to bring people a positive psychological experience and affect the aesthetic experience.

Certainly, other mechanisms are also possible, as the longstanding debate between simulation theory and theory–theory as well as other hypotheses about how we represent others' behaviors and mental states (for reviews, see Alcalá-López et al., 2019; Asakura & Inui, 2016; Gangopadhyay, 2017; Mahy et al., 2014; Musholt, 2018; Wiltshire et al., 2014) has suggested. Just as we have discussed above, the simulation theory argues that one can use their mind as a model to understand another's mind (e.g., Gordon, 1986). However, the theory–theory posits that we develop a database of theoretical, common-sense knowledge about the causal relation between observable behavior and unobservable mental states (e.g., Leslie, 1987). Thus, according to theory-theory, the stronger activation of the motor system for dynamic (vs. static) stimuli like bilateral MT (Zhao et al., 2020) or cortical motor system and the mirror and mirror-like areas (Di Dio et al., 2016; Zhao et al., 2021) does not necessarily indicate a motion simulation process but may be an outcome of associate learning between the motor system and the visual system by previous life experience (c.f., Cook et al., 2014). The single-cell recordings in humans showed that individuated neurons in the hippocampus and the amygdala located outside the so-called motor system fired both during the execution and the observation of similar actions (Mukamel et al., 2010). This result also did not support that motion simulation is the only way but that actions may be represented with an even greater abstraction (see Caramazza et al., 2014; Mahon & Caramazza, 2008 for reviews). Action understanding needs to draw inferences from general, theoretical knowledge of mental states (c.f., Gangopadhyay, 2017). The vitality of inanimate stimuli (e.g., a fluttering flag) also may appear attractive for reasons other than embodied simulation.

Taken together, dynamic stimuli were more attractive than static stimuli because dynamic stimuli had higher vitality, which increased attractiveness. The higher attractiveness of dynamic stimuli supports the frozen effect (McDowell & Haberman, 2019; Post et al., 2012). This study has provided a possible explanation for this phenomenon, that is, the mediating effect of vitality. As this effect also exists for inanimate objects, people's preference for moving objects (Chamberlain et al., 2022; Fox & McDaniel, 1982; Frankenhuis et al., 2013) may also be due to the vitality implied by their movement. Previous studies have used symmetry (Hughes & Aung, 2018), sexual dimorphism (Morrison et al., 2007), emotion (Rubenstein, 2005), or personality (Penton-Voak & Chang, 2008; Roberts et al., 2009) to explain the enhanced attractiveness of dynamic faces. However, these factors could not explain the enhanced attractiveness of dynamic inanimate objects that did not convey these attributes and the results in the present study where these attributes were not manipulated. It is possible that vitality is related to these attributes and is a more fundamental factor accounting for the frozen effect.

This study still had some limitations. First, although we proposed that dynamic stimuli may result in a stronger embodied experience due to their higher vitality, which we termed as vitality contagion, thereby enhancing the aesthetic value, the above discussions reveal that there may be no single processing underlying the vitality effect. So more research is needed to investigate the underlying mechanism.

Second, as the conclusions of this paper are based largely on observers' subjective ratings of perceived vitality and the study was run with Mandarin-speaking participants and with Mandarin words "生命力," someone may argue that the conclusion may be only limited to the research with Mandarin-speaking participants and with Mandarin words "生命力." That is, the Mandarin word "生命力" that the participants saw may evoke the different construct as the English word "vitality" that the previous references and the present paper have used. And at a more general level, the subjective ratings may not reliably capture constructs of interest. First, the definition of "生命力" is similar to that of "vitality" (Kleeman & Yu, 2010); both indicate the ability to survive and develop (Chinese Academy of Social Sciences Institute of Linguistics, 2016; Oxford University Press, n.d.). It is also commonly used to describe an enthusiasm for life and a spirit of perseverance. From this perspective, we speculate that participants' understanding of "生命力" and "vitality" should be the same. In addition, the positive effects of motion (Di Dio et al., 2016) and vitality (Di Dio et al., 2019) on the aesthetic preferences of artworks have also been found in Italy. Participants' understanding of "vitality" in different languages may be universal. Second, "vitality" is regarded as a subjective experience (Stern, 2010) or a psychological experience (Bostic et al., 2000; Ryan & Frederick, 1997), like other psychological concepts such as "attractiveness," "trustworthiness," "dominance," and so on. As the research on these topics (see Brielmann & Pelli, 2018; Carney, 2020; Rotter, 1980 for reviews), future research about the construct of "vitality" and related possible individual and cultural differences is definitely needed. Anyhow, our study contributes as one of the first that attempts to use vitality to explain the "frozen effect," at least in the Chinese context.

Third, the present study did not provide answers why the results of scrambled faces (vs. dynamic/static faces) are unstable. The role of predictability, naturalness, and objective processing fluency can be further explored in the future. Third, the effect of vitality forms varied by stimulus category. The psychological and neural mechanisms of the effect of vitality forms (exploding, fading, and pulsing) remain unclear, which is worth to be investigated in future studies. Finally, whether vitality is a more fundamental factor other than structural information (e.g., symmetry) or other nonstructural information (e.g., emotion) accounting for the frozen effect remains unclear. Future research can explore the relationships between these factors.

In conclusion, we have added evidence for the aesthetic value of vitality. This aesthetic value of vitality explains why dynamic faces are more attractive. Vitality acts as a mediator between motion and attractiveness, and this mediating effect is general, regardless of stimulus categories and vitality forms.

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(*Appendix follows*)

Appendix

Table A1

Chinese Idioms/Phrases Used for the High-Vitality, Low-Vitality, and Neutral Labels With Corresponding English Explanations in Experiment 2

High-vitality label	Low-vitality label	Neutral label
精力旺盛	死气沉沉	桌子椅子
Vigorous	Lifeless	Table and chair
充满活力	缺乏活力	沙发茶几
Lively	Unlively	Sofa and coffee table
朝气蓬勃	萎靡不振	窗户窗帘
Energetic	Unenergetic	Window and curtain
精神焕发	无精打采	文件书架
In high spirits	Spiritless	File and bookshelf
生龙活虎	昏昏欲睡	橱柜餐具
Doughty as a dragon and lively as a tiger	Drowsy	Cupboard and tableware

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