AESTHETIC RATIOS OF FLIGHT - HOW OBSERVER EXPERTISE AND AESTHETIC PERCEPTION ARE RELATED TO WEBSTER FREERUNNING SKILL FLIGHT KINEMATICS

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Abstract

The perception of (motion) aesthetics is related to the circumstances of the object, the observer, and the given context. The central question of this study is whether the perception of motion aesthetics is related to a motor skill's ratio of flight kinematics and the observer's sensory-motor experiences. Motor skills, perceived as more aesthetic, are hypothesized to show kinematic flight ratios near the golden ratio. Motor skills, perceived as less aesthetic, are hypothesized to show kinematic flight ratios farther away from the golden ratio. Furthermore, this relationship is hypothesized to be related to the observer's sensory-motor experience. Therefore, 36 participants (12 freerunning experts, 12 freerunning novices, and 12 laypeople) were asked to indicate their perception of motion aesthetics when watching video sequences of different freerunning performances. The results indicate that kinematic flight ratios and the observer's sensory-motor experience are related to the aesthetic perception of the freerunning skill. As hypothesized, kinematic ratios of Webster performances perceived as more aesthetic are closer to the golden ratio, and Webster performances perceived as less aesthetic are farther away from the golden ratio; this is significant for expert and novice freerunners, but not for laypeople. Thus, we conclude that the aesthetic perception of complex motor skills is related to kinematic flight ratios and the observer's sensory-motor expertise. Future work should incorporate such knowledge about kinematic ratios and how to address them during motor skill performances to create and perform aesthetically pleasing complex motor skills.

Keywords: *empirical aesthetics, motion perception, Likert-scale, golden ratio, videography.*

INTRODUCTION

Imagine somebody drawing the properties and ratios of an athlete's complex motor skill performance comparable to the da Vinci's drawing of the Vitruvian Man (cf. Iosa, Morone, & Paolucci, 2018). They illustrate, for example, aspects of the athlete's proportions, aspects of the skills' kinematic proportions in space and time, and each in relation to an observer and a given context. Would drawings of skillful motor skill performances reveal more aesthetically pleasing ratios and proportions compared to drawings of mediocre motor skill performances? And may such drawings be related to an observer's perception of more versus less aesthetically pleasing motor skill performances?

The central question of this study is to address whether the perception of motion aesthetics is related to the (golden) ratio of the flight kinematics of a motor skill and the observer's sensory-motor experiences.

The perception of (motion) aesthetics is related to the specific circumstances of the object, the observer, and the given context (Brielmann & Pelli, 2018; Christensen & Calvo-Merino, 2013; Vinken & Heinen, 2020). Therefore, aspects such as the properties and features of aesthetic objects, the observer's resulting response mechanisms to such objects, and the resulting interplay between the object and the observer in a given context are key topics in the study of (empirical) aesthetics (Brielmann & Pelli, 2018; Chatterjee & Vartanian, 2014; Leder & Nadal, 2014; Pelowski, Markey, Forster, Gerger, & Leder, 2017).

The golden ratio (Livio, 2003) is defined as the ratio of a shorter, minor segment to a longer, major segment, where this ratio is the same as the ratio between the longer segment to the sum of both segments, namely, the short segment plus the long segment (Iosa et al. 2018). Several mathematical and theoretical estimations reveal the number 1.618 as the so-called golden ratio between the shorter minor segment and the longer major segment. This ratio occurs, for example, in mathematical calculations, in historical observations, and in biological and evolutionary appearances (cf. Leonardo da Vinci's Vitruvian Man and the human gait cycle; Brielmann & Pelli, 2018; Iosa et al., 2018).

The question comes to mind whether the aesthetic rules of non-motion objects, such as the golden ratio, are transferable to aesthetically perceived objects in motion. For example, golden ratios are found in (human) anthropometrics (Di Dio, Macaluso, & Rizzolatti, 2007) and human gait (Iosa, De Bartolo, Morone, et al., 2019). The question arises whether those results are transferable to complex whole-body movements where the central aim is not only to achieve efficient and ecological motor performance but also to perform the motor skill so that it is perceived as skillful and aesthetic. For instance, motor skills perceived as more aesthetic may result from kinematic ratios closer to the golden ratio, whereas motor skills perceived as less aesthetic may result from kinematic ratios farther away from the golden ratio.

Research on (empirical) aesthetics either focuses on biological or nonbiological objects observed as either static or moving stimuli. For example, when observing static graphic patterns varying in complexity, symmetry, and familiarity, it is argued that symmetry and complexity are related to the observer's aesthetic perception. At the same time, familiarization with such stimuli seems to decrease the observer's aesthetic perception (Tinio & Leder, 2009). For example, static stick-figures and polygons derived from original ballet dance postures are perceived as more aesthetic by naïve dance observers when they are more vertical (Daprati, Iosa, & Haggard, 2009).

Interestingly, when trained dance teachers (Torrents, Castañer, Reverter, Morey, & Jofre, 2015), as well as naïve dance observers (Torrents, Castañer, Jofre, Morey, & Reverter, 2013), were asked to aesthetically judge stick-figure sequences of original dance skills, the authors found that specific, skill-dependent kinematic parameters were related to the observer's aesthetic perception. While dance teachers and naïve dance observers related similar kinematic parameters to the aesthetic perception of dance skills, experienced dance observers' aesthetic perception was related to more differentiated kinematic parameters (Torrents et al., 2013; Torrents et al., 2015). Consequently, we argue that research on the aesthetic perception of biological motion stimuli has to address the observer's sensory-motor experience to such stimuli observations, as well as the stimuli's properties, thus aiming to investigate the fundamental, motion-related aesthetics (Christensen & Calvo-Merino, 2013; Kirsch, Urgesi, & Cross, 2016; Orgs, Calvo-Merino, & Cross, 2018). However, such aesthetic fundamentals are less widely studied in moving biological stimuli, such as video sequences of original complex motor skill performances.

The following temporal and spatial - directly measurable or derived - parameters were found to be related to a motor stimuli's aesthetic perception: acceleration, amplitude, (body) angles, duration, frequency, height, jerk, length, position, smoothness, speed, symmetry, timing/rhythm, and (turning) velocity (Bronner & Shippen, 2015; Daprati et al., 2009; Orlandi, Cross, & Orgs, 2020; Zamparo, Carrara, & Cesari, 2017; Torrents et al., 2013). For example, dance sequences performed with uniform movement timing are perceived as less aesthetically pleasing than those performed with varied movement timing (Orlandi et al., 2020). Additionally, larger elevation angles of the gesture leg in dance poses (Daprati et al., 2009), greater motion smoothness of specific ballet skills (Bronner & Shippen, 2015), and larger amplitudes in specific dance skills (Torrents et al., 2013) are positively related to the aesthetic perception of motor skill performances. However, such parameters are hard to compare in different motion stimuli and thus partly inhibit the derivation of overall aesthetic features, which may boost and increase the aesthetic perception of a motion stimulus.

In dance and the performing arts, aesthetic features such as an extreme degree of flexibility, elongation of the limbs, and extreme turn-out positions are summarized to increase aesthetic motion perception (Christensen & Calo-Merino, 2013). Furthermore, smooth and fluent dance moves are preferred aesthetically (Orgs et al., 2018). However, it remains open which kinematic parameters describe such smooth and fluent (dance) moves and how, for example, different ratios between such parameters drive aesthetic motion perception. On the other hand, complex motor skill performances are based upon and restricted to the laws of physics. For example, motor skills containing a flight phase must be performed in specific variations of kinematic parameters (Schmidt, Lee, Winstein, Wulf, & Zelaznik, 2018). However, (expert) performers can use kinematic and perceptual possibilities, as well as the constraints of their motor skill performance, to their full potential. This could, for example, be achieved by increasing flight height at the cost of flight width or vice-versa. It is thus of special interest whether one or the other, and their resulting kinematic ratios, are related to an observer's aesthetic perception of motor skill performance.

In sport and human movement science, researchers and practitioners aim to find, address, and train kinematic properties to optimize movement quality, performance outcome, and motor economy (Schmidt et al., 2018). In technical and aesthetic sports, this is of additional importance, especially when motor skill performances are estimated, judged, and perceived by an observing audience (Bar-Eli, Plessner, & Raab, 2011). In the Code of Points for gymnastics, parkour, and artistic performances (cf. *Laban score* as an estimate of time, space, weight, and flow performance; Newlove & Dalby, 2004), the quality and execution of complex motor skills are determined by observations of, for example, the E-Score as an estimate of execution and artistry of performance (*Fédération Internationale de Gymnastique* [FIG], 2016), or as an estimate of flow, mastery, and amplitude of skill performance (FIG, 2019). However, such codes of points and score systems lack specific kinematic measures, ratios, and calculations but rely on the judge's perceptual abilities when observing and evaluating motor skill performances.

Taken together, the research suggests a relationship between sensory-motor experience and aspects, such as perception, cognition, and action (Gibbs, 2005). Furthermore, a so-called embodied relationship between a person's sensory-motor experience and the perception, cognition, and performance of this person's perception and behavior of motor skills is discussed (Kirsch, Drommelschmidt, & Cross, 2013; Vinken, Stirling, & Heinen, in press). We also suggest that the aesthetic perception of (golden) kinematic ratios may be related to the observer's sensory-motor experiences. Aspects of *knowledge* *meaning*, such as familiarity with the perceived stimuli, are related to the aesthetic perception of observers with different sensory-motor experience (Chatterjee & Vartanian, 2014; Orgs et al., 2018; Pelowski et al., 2017; Tinio & Leder, 2009). However, it remains to be investigated whether the kinematic parameters of motor skill performances rely on golden ratio proportions and whether these ratios could be related to the observer's sensory-motor experience. Addressing this question provides an insight in the question of whether the (golden) kinematic ratios of complex motor skills are related to the aesthetic perception of motor stimuli, in general, or in relationship to observer-specific sensory-motor experiences, in more detail. Furthermore, it should be addressed whether kinematic ratios of complex motor skill performances could be implemented to optimize motor skill performances as being (more) aesthetically relevant and pleasing.

We thus hypothesize that motor skills that are perceived as more aesthetic show kinematic flight ratios near the golden ratio, and the kinematic flight ratios of motor skill performances that are perceived as less aesthetic are farther away from the golden ratio. Furthermore, we hypothesize that this relationship is related to the observers' sensory-motor experience.

METHODS

We recruited N = 36 participants (30 males, five females, one other), and they were assigned to one of three groups: 1) n_{ExpObs} = 12 freerunning experts (24 ± 3 years) with a reported average freerunning experience of 8 ± 2 years, 2) n_{NovObs} = 12 freerunning novices (22 ± 10 years) with a reported average freerunning experience of 2 ± 1 years, and 3) n_{LayObs} = 12 laypeople (28 ± 9 years) who reported having no freerunning experience. Freerunning experience was totaled from leisure, sport, and championship activities. We asked participants to indicate their perception of motion aesthetics when watching video sequences of the Webster freerunning skill.

Additionally, we recruited another sample of N_{Perf} = 7 freerunners (six male, one female; 21 ± 5 years) with the aim of generating stimuli video sequences. These freerunners reported having an average freerunning experience of 6 ± 3 years and a weekly training of 9 ± 5 hours. They were included when they were able to perform and execute the Webster skill successfully, stably (Schmidt et al., 2018), and according to the experimental settings of this study (cf. Fig. 1).

All participants were recruited in Germany, participated voluntarily in this study, and signed an informed consent form prior to the beginning of the study. The study was conducted according to the local university's ethics guidelines.

The procedure to generate stimuli was similar to that followed by Vinken and colleagues (in press). The relevant steps are summarized in this paragraph for the sake of completeness and to be able to replicate this study.

First, video stimuli generation was done by inviting the freerunners of the stimuli sample to perform the Webster skills in the given experimental setting (cf. Fig. 1) and after an individual warm-up phase. We instructed each freerunner to perform variations of the Webster freerunning skill by focusing on different accentuations of flight width, flight height, and body posture(s). After successfully performing the Webster skills and their possible variations, each freerunner was debriefed. Freerunners performed the Webster skills in a prepared area of 10 x 20 meters, and their performances were video-taped. The implemented digital camera (Panasonic Lumix G7) operates at 50 Hz (1920 x 1080 pixels), was positioned ten meters away and orthogonal to take-off and landing area, and recorded each Webster freerunning skill. Sixteen video sequences with sufficient movement quality and without background irritations or emotional expressions were captured from the performing freerunners and transferred into grayscale color to reduce contextual visual biases.

Second, we determined the width of flight and height of flight of each performed Webster skill and calculated a ratio implementing the following equation (cf. Iosa et al., 2018):

Kinematic ratio = 0.5 x width of flight / height of flight

The width of flight and height of flight were determined and measured using video analysis software (*Tracker*, version 5.1.5, 2020). The width of flight was measured as the distance between the freerunner's center of mass position during take-off and the freerunner's center of mass position during landing. Height of flight was measured as the distance between the freerunner's center of mass position during take-off and the freerunner's highest center of mass position during the flight phase. We calculated the freerunner's center of mass during take-off, highest flight position and landing based on a segmental analysis of the human body (Enoka, 2015).

Figure 1 illustrates the determination of the width and height of flight and the resulting calculation of the ratios within an exemplary Webster performance.

We used an online questionnaire (*SoSci Survey*; version 3.0.00, 2018) for the presentation and evaluation of Webster video sequences to measure participants' perception of motion aesthetics when observing video sequences of different Webster performances.

Within the questionnaire, each video sequence was presented randomly and in the middle of the screen. A seven-point Likert-scale labeled "aesthetic" ranging from -3 via 0 to +3 (Palmer, Schloss, & Sammartino, 2013) was positioned below each video sequence. We asked the participants to indicate their individual perception of motion aesthetics of each freerunning skill with the help of the Likert scale. The instruction was "please indicate how aesthetic you perceive the video sequence to be by ticking the number representing your subjective perception. There is no right or wrong answer, and we are interested solely in your individual aesthetic perception". The self-paced survey containing the presentation and evaluation of the video stimuli took approximately ten minutes per participant. There was no instruction of the terms "aesthetics" and "aesthetic(ally)" to leave their meaning solely to the participants and as unbiased as possible (cf. Jacobsen, Buchta, Köhler, & Schröger, 2004).

Sixteen responses were recorded by each observing participant, leading to a total of N = 36 participants x 16 responses = 576 separate values for data analysis.

The study was conducted in the following phases. First, we invited the participants via e-mail and sent them a link to the online questionnaire. When following the invitation link, the participants were informed about the general purpose of this study, had to agree to signing an informed consent form and were asked questions about their freerunning experience. The participants' task was to indicate their perception of motion aesthetics when watching different video sequences of the Webster freerunning skill using a Likert scale. The video sequences of different Webster performances were randomly presented to each participant in the original tempo. The observing participants were instructed to indicate their response spontaneously but without time pressure. After successfully finishing the evaluation of the video sequences, the participants were debriefed and received contact details if they were interested in future studies and research. Second, the answers given by the observing participants were recorded online and used for later data analysis with the help of a spreadsheet and statistical software. Third, we calculated the median splits of the Likert-scale ratings of each observer group (experts, novices, and laypeople) to differentiate Webster performances perceived as more aesthetic from those that were perceived as less aesthetic.

Additionally, we determined the width and height of flight of each Webster performance and calculated the kinematic ratio of each Webster performance with the help of the following formula:

Kinematic ratio = 0.5 x width of flight / height of flight

An *a* = 5% significance level was used for all results reported. Separate two-sample *t*-Tests (Websters perceived as more vs. less aesthetic) were calculated to compare the corresponding means of the Webster ratios for each of the two samples in expert freerunners, novice freerunners, and laypeople. *Cohen's d* was calculated as an effect size for all significant results.

RESULTS

Figure 2 illustrates the means and standard errors of the kinematic ratios of the Webster performances perceived as more vs. less aesthetic by expert freerunners, novice freerunners, and laypeople. In general, the ratios of Webster performances that are perceived as more aesthetic are closer to 1.618 (dashed line), and the ratios of Webster performances that are perceived as less aesthetic are farther away from 1.618 (dashed line). More precisely, expert freerunners perceive Webster performances with a ratio closer to the golden ratio as significantly more aesthetic compared to Webster performances with a ratio farther away from the golden ratio ($t(14) = 2.243$, $p = .021$, *Cohen's d* = 1.121). Furthermore, the relationship between the kinematic ratios and the motion aesthetics of the Webster skills perceived by the novice freerunners revealed the same pattern of results ($t(14) = 1.800$, $p = .047$, *Cohen's d* = 0.900), whereas this was not significant among the laypeople.

The double periodization model was used in the planning with the first macrocycle of 28 weeks between January and July (date of the Olympic Games), divided into three distinct blocks: A (Basic), B (pre-competitive) and C (competitive), but correlated (Siff & Verkhoshansky, 2004; Verkhoshanski, 2001), with the main characteristic of concentrated and distributed loads throughout the training cycle. The worksheet of the first macrocycle is shown in Figure 1; the second macrocycle is not addressed in this study.

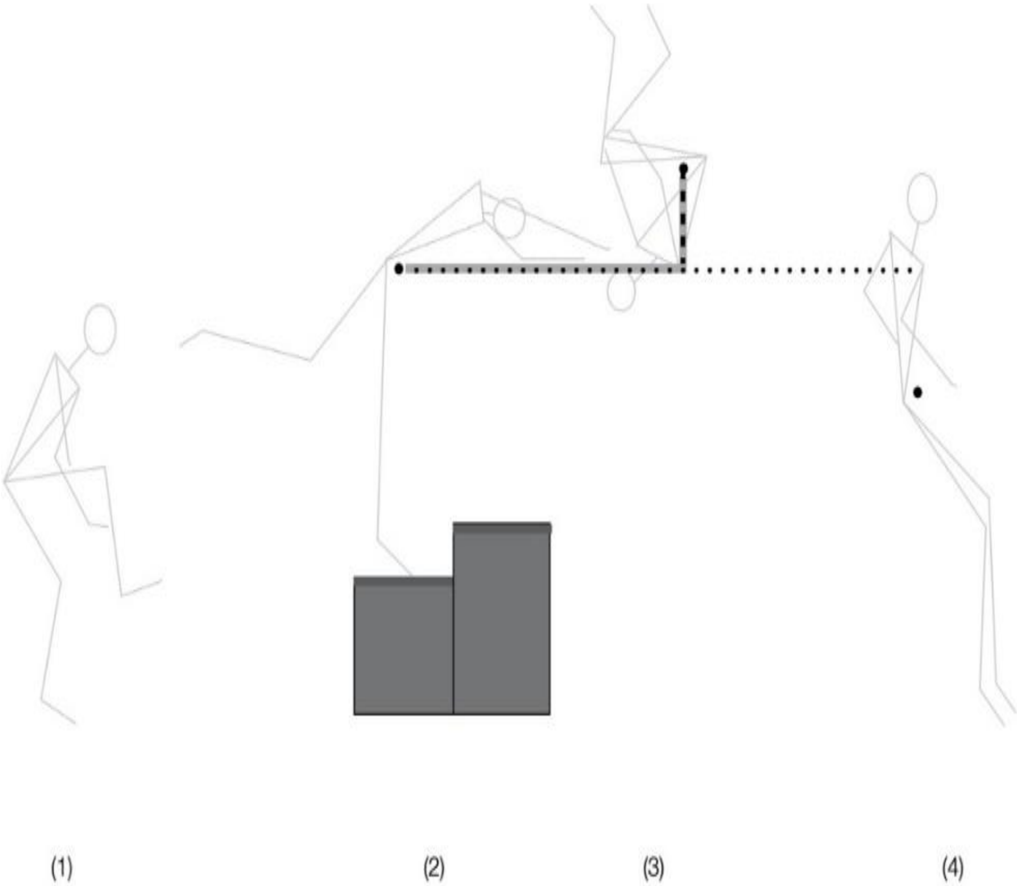

Figure 1. Webster freeerunning skill, performance setup, and calculation of kinematic ratio. Stick-figure sequence of an exemplarily Webster performance illustrating the following four movement phases: (1) approach of the obstacle, (2) take-off, (3) maximum height of flight, and (4) landing, the calculation of width and height of flight, and the calculation of the kinematic ratio.

The black dots represent the performer's center of mass position during take-off, maximum height of flight, and landing. The dotted line represents the width of flight as the horizontal distance between the center of mass position during take-off and the center of mass position during landing. The dashed line represents the height of flight as the vertical distance between the center of mass position during take-off and the center of mass position during maximum height of flight. The bold, grey line functions as the illustrated indication of the calculated kinematic ratio = 0.5 x width of flight / height of flight.

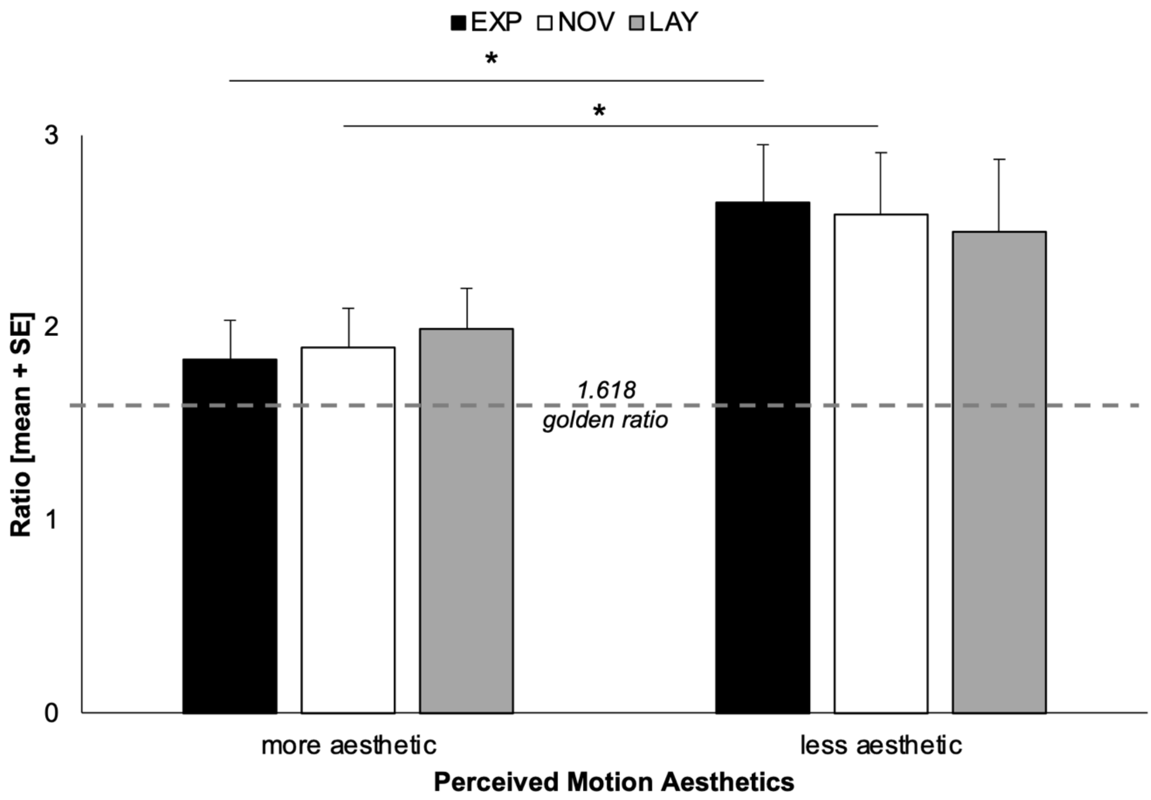

Figure 2. Kinematic ratios of Webster performances and observer's perceived motion aesthetics. Illustration of kinematic ratios of Webster performances perceived as more vs. less aesthetic from expert freerunners, novice freerunners, and laypeople. The dashed grey line indicates the golden ratio of 1.618. * denotes $p \leq 0.5$.

The basic stage (Block A) contained the largest training volume of the entire season. Its objective was to destabilize previous performance levels, aiming to increase strength gains, with greater emphasis on the total volume of repetitions to obtain greater adaptation of the neuromuscular complex to be used (Verkhoshanski, 2001). The central objective was the elevation in the motor potential of the athlete, ensured by a high volume of means and special training methods with emphasis on strength.

The pre-competitive stage (Block B) developed the increase in strength and speed capacity (explosive strength), decreased the volume and increased the intensity of training, to intensify the muscle tension index and activate the neuromuscular system (Verkhoshanski, 2001). Thus, the volume was reduced, and specific loads were accentuated, especially the more intense ones, supported by the foundation created by the morphological and functional changes in the system.

Finally, in the competitive stage (Block C) of the macrocycle, the main objective was training with low volume and greater intensity so that training became more specific to the sport. It was characterized by a greater incidence of competitive loads which aimed to consolidate the athlete's readiness at the highest level and coincided with major competitions.

Figure 2 presents the distribution of the physical preparation variables (means, method, sets, repetitions, load and rest) between the training Blocks. Comparing the variables in the Blocks, an adjustment of values and items from a general training organization to a specific organization of the routine on the apparatus can be observed: a decrease of sets and repetitions, a load increase until close to the maximum relative strength, and a rest increase.

Figure 3 presents the distribution of the technical preparation between the days of the week in accordance with the training Blocks. Comparing the days in each Block, a few modifications in the combination of movements are notable, adapted to the gymnast's individual needs. However, when considering the distribution during the week, there is a variation in the movements and methods. As for the apparatus, there is the construction of the routine to be presented, with the refinement of movements and combinations of technical elements acquired and new combinations, in line with the gymnast's partial results and scoring needs.

DISCUSSION

In this study, we aimed to investigate whether the perception of motion aesthetics is related to the (golden) ratio of flight kinematics of a motor skill. We hypothesized that the motor skills that are perceived as more aesthetic would have kinematic flight ratios closer to the golden ratio, and motor skills that are perceived as less aesthetic to have kinematic flight ratios would be farther away from the golden ratio. Additionally, we hypothesized that this finding would be related to the observers' sensory-motor experience. To calculate the kinematic ratio of the Webster performances, we used the following formula: *Kinematic ratio = 0.5 x width of flight / height of flight.*

As hypothesized, the kinematic ratios of the Webster performances perceived as more aesthetic were closer to the golden ratio (1.618, cf. Iosa et al., 2018; Livio, 2003) and the Webster performances perceived as less aesthetic were farther away from the golden ratio (1.618). Furthermore, expert and novice freerunners perceived the Webster performances with a ratio closer to the golden ratio as significantly more aesthetic than the Webster performances with a ratio farther away from the golden ratio. Laypeople's aesthetic perception was not significantly related to the kinematic ratios of the Webster performances.

Interestingly, the ratio of width and height of flight in the Webster performances is related to the aesthetic perception of those Webster performances, and the Webster performances with kinematic ratios closer to the golden ratio are perceived as being more aesthetic. While this relationship can be observed in all three observer groups, it is significant for expert and novice freerunning observers, and is not significant in laypeople. Therefore, the observer's sensory-motor experience seems to be related to the kinematic and aesthetic perception of complex motor skills, such as the Webster freerunning skill. In complex motor skills, where a flight phase with or without a salto or twist rotation is performed, flight kinematics are restricted to the laws of physics, and variations in those flight phases require the athlete's ability and expertise to vary skill performance while still achieving sufficient technical, secure, and high-quality performance. A *golden* kinematic ratio of width and height of flight during Webster performances either requires increased width of flight at the cost of height of flight, or increased height of flight at the cost of width of flight. A technical requirement that can only be addressed when considering the laws of physics and mechanics (Schmidt et al., 2018). For example, an increased width of flight requires a given amount of height of flight. Future studies may address and expand our finding in such a way that mathematical calculations and manipulations of a motor skill's flight kinematics are performed and then again related to the observer's perception of motion aesthetics to investigate aesthetically optimized flight kinematics within a given complex motor skill.

Previous research has revealed golden ratios in sculpture proportions, gait kinematics, and locomotor skills (Di Dio et al., 2007; Iosa et al., 2019). The results of our study now add that such golden kinematic ratios can also be found in complex motor skills requiring a flight phase, such as the Webster freerunning skill. We thus expect similar findings for motor skill performances that are technically and mechanically similar to Webster skills. We suggest, for example, that salto performances in artistic gymnastic routines or *grand jeté* jumps performed in classical ballet will be perceived as more aesthetically pleasing for observers, judges, and the audience when having flight kinematics of width and height of flight that are closer to the golden ratio and thus fulfill technical, qualitative, and aesthetically pleasing requirements.

In addition, the results of our study confirm that complex motor skills, such as the Webster freerunning skills, are perceived as being more aesthetic when possessing kinematic flight ratios closer to the golden ratio and that this finding is especially true when experienced observers aesthetically perceive and estimate complex motor skills. We suggest that naïve observers may already be aesthetically impressed by the complexity of the motor skill performance per se (cf. *which* movements are performed matters, Orlandi et al., 2020). In contrast, experienced observers may value the art of complexity, ability, and quality of motor skill performance (cf. *how* movements are performed matters, Orlandi et al., 2020). Taken together, when aiming to aesthetically impress experienced observers, the art of motor skill performance seems to aesthetically impress more when kinematic flight ratios are closer to the golden ratio.

However, when interpreting the results of our study, the following three limitations should be considered. First, we assessed the kinematic ratios and observers' aesthetic perception of the Webster freerunning skill on the basis of original video stimuli of experienced freerunning performers. Whether motor skill performances at different levels of expertise, ratios with different kinematic parameters, or different motor stimuli would reveal comparable results should be investigated further. Furthermore, we propose that the results of our study are transferable to other motor skills that include a flight phase and similar technical and mechanical structures (cf. closed skills with take-off phase, flight phase with or without a salto and twist rotation, landing phase; Schmidt et al., 2018) such as the Webster freerunning skill.

Second, we assessed the original stimuli of the freerunning motor skill performances. Future studies should investigate whether, for example, the manipulation of kinematic parameters within artificial or designed motor stimuli would reveal similar results. Additionally, one may derive suggestions about which direction the observer's aesthetic perception can be shifted in terms of over- or underachieving kinematic golden ratios within complex motor skill performances, for instance, by implementing eye-tracking methodologies.

Third, we behaviorally assessed the aesthetic perception of observers with different sensory-motor experiences in freerunning and calculated the kinematic parameters of flight width and height based upon videography. This was done to capture observers' perceptions of motion aesthetics as unbiased, natural, and economic as possible (Jacobsen et al., 2004; Palmer et al., 2013; Schmidt et al., 2018). However, additional parameters that can be assessed and potentially be related to the aesthetics of a motor skill performance are, for example, performers' rates of exhaustion and/or satisfaction during a motor skill performance, as well as the (golden) ratios of the contextual circumstances within a motor skill performance, such as body proportions, ornamentations, and configuration of the performing scenery. Finally, the sociocultural influences within the observer groups and contexts may be worth investigating.

The practical implications our study can reveal for coaches and practitioners are how and why to optimize the width and height of flight when aiming to perform Webster skills that are aesthetically pleasing. Therefore, given the formula mentioned above, the freerunner should be instructed to perform the aesthetically pleasing Webster skill by achieving a width of flight that is close to three times the height of the flight (1.618 = 0.5 x width of flight / height of flight ⇔ 3.236 x height of flight = width of flight). The practical implications for researchers in empirical aesthetics as well as in sport and human movement science are that the observer's sensory-motor experience is related to the perception of motion aesthetics and motor performance. Therefore, the technical and kinematic properties of motor stimuli are related to the subjective aesthetic perception of such motor skills and can be objectified and calculated.

CONCLUSION

Kinematic flight ratios of a complex motor stimulus seem to be related to the observer's aesthetic perception. When perceiving and evaluating the aesthetic perception of different variations of a freerunning skill, namely, the Webster skill, expert freerunners, novice freerunners, and laypeople differ in their aesthetic perception of motor skills with different kinematic flight ratios. We suggest that naïve observers may already be aesthetically impressed by the complexity of the motor skill performance per se, whereas (more) experienced observers may value the art of complexity, ability, and quality of motor skill performance. Thus, we conclude that when aiming to create and perform complex motor skills that should aesthetically impress an audience, this is more challenging when creating and performing for a (more) experienced audience. Furthermore, knowledge about kinematic ratios and how to address them during motor skill performances may help researchers, practitioners, and choreographers create aesthetically pleasing complex motor skills and stimuli. Future studies should investigate whether this is transferrable to different motor stimuli, different observer groups, and different contexts in which aesthetic motion perception occurs, thus providing fruitful and promising outcomes, especially when researchers and practitioners join their aesthetic perceptions and experiences.

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