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Smile stimuli induce better performance in tests performed by children and adolescents practicing jiu-jitsu

Impacto de la estimulación emocional en el rendimiento de niños y adolescentes practicantes de jiu-jitsu

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Abstract. Aims: This study compared the performance of children and adolescents practicing jiu-jitsu when stimulated or not stimulated to smile before specific and non-specific physical tests. Methods: 268 children and adolescents (male=168) were measured in 5 tests (30" by 3' interval) of which 3 were specific (4-Leg Exercise, Gyaku-tsuki test and O-soto-otoshi nage-komi test) and 2 non-specific (Side jumps and Burpees). These tests were carried out under two conditions: a) without prior stimuli; b) after joy stimuli. Results: There was an isolated effect of the pre-test intervention for non-specific tests, with better performance after joy stimuli (Side jumps: 35.8±13.3 vs. 30.1±11.1; Burpees: 16.1±5 .3 vs. 13.8±4.8 repetitions; p≤0.001 for both comparisons). There were also isolated effects of the pre-test intervention for the specific O-soto-otoshi nage-komi test and 4-Leg Exercise, where happiness stimuli resulted in better performance (O-soto-otoshi nage-komi test: 15.2±3.5 vs. 12.5 ± 3.7 repetitions; 4-Leg Exercise: 3.5±1.2 vs. 2.8±1.2 repetitions p≤0.001 for both comparisons). For the Gyaku-tsuki test, there was an interaction effect between intervention and age (p=0.02), where older children performed better. Conclusion: Stimulating emotions of happiness brings better performance in children and adolescents practicing jiu-jitsu regardless of gender and age, except for the Gyaku-tsuki test where older people tend to perform better.
Keywords: martial arts, emotion, children, adolescent, performance.

Resumen. Objetivos: Este estudio tuvo como objetivo comparar el rendimiento de niños y adolescentes que practican jiu-jitsu cuando se les estimula o no a sonreír antes de pruebas físicas específicas y no específicas. Métodos: Se midieron 268 niños y adolescentes (168 varones) en 5 pruebas (30 segundos con un intervalo de 3 minutos), de las cuales 3 eran específicas (Ejercicio de trabajo de suelo en cuadrupedia, prueba de Gyaku-tsuki y prueba O-soto-otoshi en nage-komi) y 2 no específicas (Saltos laterales y Burpees). Estas pruebas se realizaron bajo dos condiciones: a) sin estímulos previos; b) después de estímulos de alegría. Resultados: Hubo un efecto aislado de la intervención preprueba para las pruebas no específicas, con un mejor rendimiento después de estímulos de alegría (Saltos laterales: 35.8±13.3 vs. 30.1±11.1; Burpees: 16.1±5.3 vs. 13.8±4.8 repeticiones; p≤0.001 para ambas comparaciones). También se observaron efectos aislados de la intervención preprueba para la prueba específica de O-soto-otoshi en nage-komi y el Ejercicio de trabajo de suelo (cuadrupedia kesa gatame), donde los estímulos de alegría obtuvieron un mejor rendimiento (Prueba O-soto-otoshi en nage-komi: 15.2±3.5 vs. 12.5±3.7 repeticiones; Ejercicio de suelo: 3.5±1.2 vs. 2.8±1.2 repeticiones p≤0.001 para ambas comparaciones). Para la prueba de Gyaku-tsuki, hubo un efecto de interacción entre la intervención y la edad (p=0.02), donde los niños mayores tuvieron un mejor rendimiento. Conclusión: Estimular las emociones relacionadas con la alegría mejora el rendimiento en niños y adolescentes que practican jiu-jitsu, independientemente del género y la edad, excepto en la prueba Gyaku-tsuki, donde los niños mayores tienden a desempeñarse mejor.
Palabras clave: artes marciales, emoción, niños, adolescentes, rendimiento.

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Introduction

Jiu-jitsu, also known as *ju-jutsu* or *jiu-jutsu*, is an ancient body fight, whose name means gentle (Hopkins, 2015). Some styles of jiu-jitsu currently practiced around the world are Brazilian Jiu-jitsu and Japanese Jiu-jitsu. In Brazilian jiu-jitsu, despite the use of projection techniques, the fight occurs predominantly on the ground, with passing movements, sweeps, joint luxation and strangulation (Chinkov & Holt, 2016). In Japanese jiu-jitsu, in addition to these movements, the body fight involves traumatizing techniques with fists, legs, elbows and the use of weapons (Hopkins, 2015; Pietraszewska et al., 2014). Regardless of the type of jiu-jitsu, people from different countries practice this fight, whether for self-defense or for combat sport. The main motivations associated with the practice of jiu-jitsu involve the Psychological, Physical condition and Interpersonal dimensions, with stress control being an important factor when choosing this combat sport. (Sugden, 2021). These motivational factors for practicing jiu-jitsu are probably stimulated by the possibility of channeling aggressive feelings into fighting techniques and by the emotions generated by physical contact, as when we interact with another practioner, relationships of trust, reciprocity, solidarity and care for others are established (Fernández, Brito, Miarka, & Díaz-de-Durana, 2020). Therefore, relationships of friendship and feelings of affection are established in the interaction with others, and the smile appears as an expression of the feelings created, as a form of social communication (Woodman et al., 2009). When we smile, hormones such as endorphins are released, which cause a feeling of pleasure and well-being and reduce fear and anxiety in the face of adverse events (Garcia-Falgueras, 2015), justifying the choice to practice a combat sport to control stress

(Valdés-Badilla et al., 2021). The effect of emotions on athletic performance has been the subject of some studies (Calleja-González et al., 2018; McCarthy, 2011; Rathschlag & Memmert, 2013; Woodman et al., 2009). This is an area still in development where there are theoretical models to explain the ergogenic (improvement performance) effect of positive emotions, but there is a lack of intervention studies that can prove such theories (McCarthy, 2011). In this sense, Rathschlag & Memmert (2013) observed that positive emotions can have an ergogenic effect on the performance of sprint runners. However, emotions can have different effects on athletic performance, according to Woodman et al. (2009), anger is associated with better muscle strength performance, especially in introverted athletes and hope produces better reaction time in football players. Specifically, regarding smile stimuli, there is limited literature published to date. Two studies have shown that coaches' smiles can have a positive effect on their athletes' performance (Broch, 2015; Furley & Thrien, 2023). Therefore, there is a lack of studies that allow us to know whether there is an ergogenic effect when stimulating positive emotions in sports practitioners. To the best of our knowledge, there are no studies that have measured this effect in children and adolescents who practice Japanese jiu-jitsu. This lack of scientific knowledge leads us to question how positive emotion can influence sports performance. In this sense, the aim of this study was to compare the performance of children and adolescents practicing jiu-jitsu when stimulated or not stimulated to smile before specifics and non-specifics physical tests. We hypothesized that children and adolescents encouraged to smile performed better in tests, whether specific or not.

Materials and methods

Experimental design

This protocol was designed to verify the effect of positive emotions on the performance of children and adolescents submitted to specific and non-specific jiu-jitsu physical tests. To this end, a group of children and adolescents (three to 14 years old) were measured in two conditions: a) on the first day, all participants performed the tests without any type of stimulus; b) on the second day, everyone performed the same tests, however first they received stimuli that awakened joy in the participants. All procedures were previously approved by the ethics committee of the university where the study was carried out (CAAE: 34176720.0.0000.5546; protocol number: 4.169.760.) and all included participants had signed consent from their parents.

Participants

Initially, we contacted with the national Spanish coach of Jiu-Jitsu in order to gain access to youth clubs contacts and present the aims of this study. The sample was made up of children born between the years 2009-2018 from the following communities: Tres Cantos (n=98, with 46 male children) and Leganés (n=170, with 112 male children). The following criteria were adopted for inclusion: a) ≥6 months of jiu-jitsu practice; b) birth between 2009-2018; c) parental permission to participate in the study. The following criteria were adopted for exclusion: a) did not participate in all stages; b) errors in data collection. Initially, 269 children and adolescents were included, however, 1 was excluded due to a collection error. Therefore, the final sample consisted of 268 children. Table 1 shows the sample size in each age group. Due to the lower frequency of participants, those born in 2008, 2009 and 2010 were grouped together, as well as those born in 2017, 2018 and 2019.

Table 1.
Distribution by sex among different age groups.

Age (years)	Female	Male	Total
3 a 5	6	12	18
6	12	19	31
7	12	23	35
8	16	31	47
9	19	25	44
10	12	26	38
11	10	20	30
12 - 14	13	12	25
Total	100	168	268

Procedures for data collection

To collect data, the researchers traveled to clubs in the two regions included in the present study. Initially, the researchers held a meeting with parents (or legal guardians) and coaches. After this, the researchers elaborated a battery to evaluated the physical performance of the children. To compose this evaluation protocol, the authors chose exercises that are commonly performed in classes and training in this combat sport. All participants were already familiar with the exercises applied for at least one year. This procedure was adopted by the researchers to avoid learning bias in the participants' performance (M Newell & Liu, 2012). All tests were carried out in the respective jiu-jitsu clubs with the presence of the coaches. Two non-specific and two specific jiu-jitsu tests developed by the researchers were applied, with an interval of 3 minutes between each test, as shown in Figures 1 and 2.

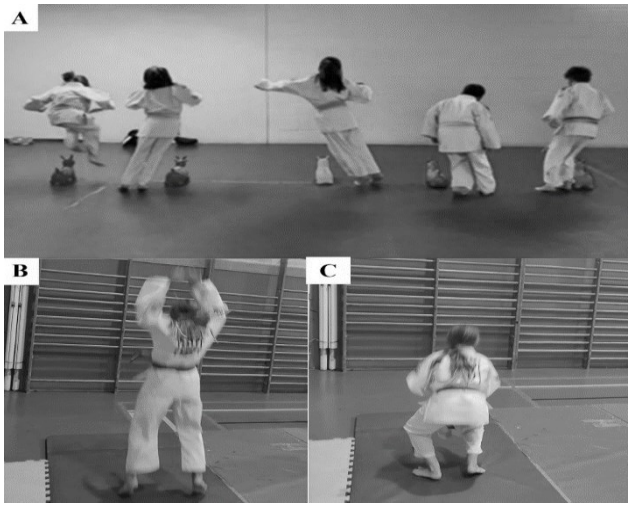

Figure 1. Non-specific tests. A – Side jump; B and C – Burpees. Original.

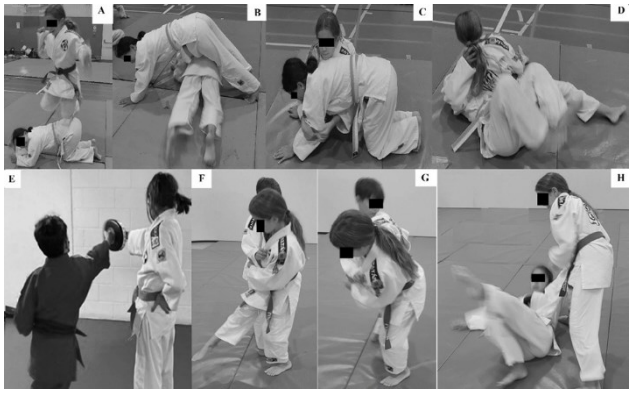

Figure 2. Specific tests. A, B, C and D – 4-Leg Exercise; E – *Gyaku-tsuki test*; F, G and H – *O-soto-otoshi nage-komi* test. Original.

Non-specific tests were performed in the following order: a) Side jump (Figure 1A): consists of jumping with feet together over 20 cm obstacles (rubber donkey) as quickly as possible for 30 seconds. b) Burpees (Figure 1B, 1C): the participants performed as many burpees as possible in 30 seconds. In sequence, 3 specific tests were carried out: a) 4-Leg Exercise (Figure 2A, B, C, D): in this exercise the children are divided into pairs, child A jumps over child B (who is in a position on all fours), then child A passes under child B and performs a turning technique and subsequent control with an immobilization (*Kesa-gatame*); b) *Gyaku tsuki* test (Figure 2E): the participants performed the greatest number of punches (*Gyaku-tsuki*) in 30 seconds against a punch pad; c) *O-soto-otoshi nage-komi* test (Figure 2F, G, H): the participants, who were divided into groups of three, threw both static partners (one at a time) as many times as possible in 30 seconds. The evaluators calculated for the final score only the executions carried out using the correct technique, as exemplified in Figure 2. To ensure that there were no biases in data collection, the researchers who carried out the tests were independent and only had contact with the children after the smile stimuli had been induced or not. Furthermore, the evaluators who measured the physical tests were blinded as to the previous condition (smile stimulation or not). Figure 3 showed the chart of procedures applied to the data collection.

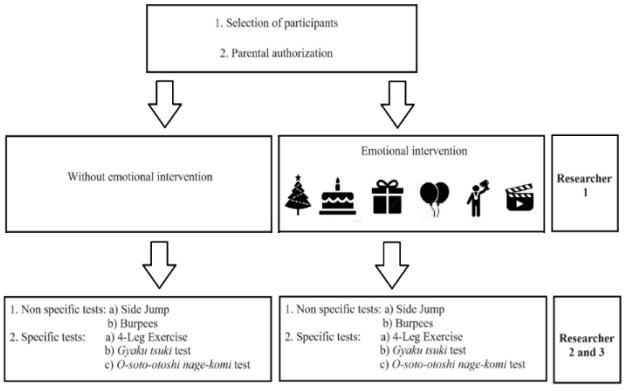

Figure 3. Sequence of procedures to achieved the data collection.

Pre-test intervention

All children had to complete the tests in two days. In the first data collection, the children performed the exercises mechanically and guided by one of the evaluators. Participants sat for 90 seconds and after this period, two evaluators observed whether there were contractions in the muscles associated with the smile (levator anguli doris; levator labii superioris; orbicularis oculi; risorius; zygomaticus major and zygomaticus minor), in accordance with previously described procedures by Abel & Kruger (2010), as exemplified in Figure 4.

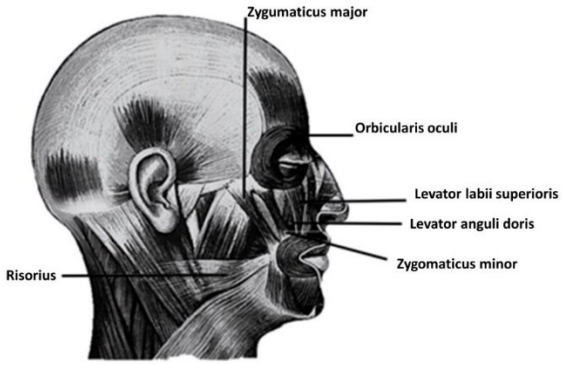

Figure 4. Anatomical location of the six muscles monitored to evaluate the effectiveness of joy stimuli.
(Adapted from Tratado de Anatomía Humana. L.Testut & A. Latarjet. (1979) Vol. 1, pag. 786, fig 762.).

In the second data collection, an emotional intervention (lasting 90 seconds) was introduced, which aimed to generate feelings of joy in participants before the physical tests. This procedure was carried out individually and consisted of 3 activities: a) The participants were encouraged to remember dates that bring happiness (for example, birthdays, Christmas); b) The participants were encouraged to create positive images for their future; c) Images of smiles and happiness from an animated film (Inside Out) were used. Next, the evaluators repeated the procedures of the first collection, analyzing the muscles associated with the smile (Abel & Kruger, 2010). For this evaluation, a researcher trained for this type of measurement carried out all analyses. After the stimuli described above, the evaluator observed the movement of the muscles as described in Figure 4 and noted whether there was activation of the muscles responsible for the smile (movement of muscles around the mouth and corners of the eyes; i.e., contraction of both zygomatic and orbicularis oculi muscle; levator anguli oris; levator labii superioris; orbicularis oculi). If there was a positive effect, the evaluator marked the completion of the activity as effective. In our study, all the stimuli used by the evaluators were effective in promoting the participants' smile. This researcher did not participate in the application of physical tests to avoid any bias related to the quality of the data.

Statistical analysis

Initially, the data were compiled into contingency tables and the Kolmogorov-Smirnov test was applied to verify normality assumptions. Since the assumptions of normality were not violated, we compared the effect of emotion (happy or neutral) on performance in the 5 tests performed using two-way ANOVA, with sex and age group as control variables. For all analyzes $p \leq 0.05$ was considered significant.

Results

Table 2 presents the results for non-specific physical tests. For the total number of side jumps ($F=61.646$; $\eta p2=0.197$; $p \leq 0.001$) and burpees ($F=38.286$; $\eta p2=0.132$; $p \leq 0.001$) there was an isolated effect of smile stimulation, where the better results were observed after the smile stimulation [Jumps: 5.7 (2.4; 10.1) rep.; Burpees: 2.3 (0.4; 6.1) rep.; $p \leq 0.001$ for all comparison].

Table 3 shows the results for the *O-soto-otoshi nage-komi* and 4-Leg Exercise specific tests. There was an isolated effect of smile stimulation for the total of *O-soto-otoshi nage-komi* test ($F=112.323$; $\eta p2=0.308$; $p \leq 0.001$) and 4-Leg Exercise ($F=68.157$; $\eta p2=0.213$; $p \leq 0.001$).

Table 2.
Results for non-specific tests in children and adolescents of both sexes.

Age (years)	Female	Male	Total	Female	Male	Total
	Jump (repetitions)			Jump SS (repetitions)		
3-5	18.8±6.7	20.9±10.5	20.2±9.3	21.7±6.7	25.8±11.6	24.4±10.2
6	19.3±5.0	23.9±10.5	22.1±9.0	24.6±8.5	28.9±9.0	27.2±8.9
7	20.5±4.8	24.7±5.9	23.1±5.8	26.0±12.8	30.1±7.9	28.7±9.9
8	29.9±9.4	28.4±11.2	28.9±10.5	35.3±6.6	35.6±13.2	35.5±11.3
9	31.2±8.5	35.0±9.4	33.4±9.2	42.9±14.8	38.4±12.2	40.3±13.4
10	33.1±9.4	34.4±9.8	34.0±9.6	37.9±10.4	40.3±13.0	39.5±12.1
11	36.3±11.2	37.3±9.7	37.0±10.0	43.9±13.3	41.4±15.4	42.2±14.5
12-14	35.4±9.6	43.8±8.9	39.4±10.0	40.2±12.0	48.8±10.8	44.4±11.9
Total	28.7±10.3	31.0±11.4	30.1±11.1*	35.8±13.2	36.2±13.3	35.8±13.3*
Age (years)	Burpees (repetitions)			Burpees SS (repetitions)		
3-5	10.7±3.0	13.9±3.5	12.8±5.0	13.8±5.0	15.0±4.4	14.9±4.0
6	12.5±3.9	12.2±3.5	12.3±5.2	14.3±4.0	14.9±3.9	14.8±5.5
7	14.3±3.9	14.2±3.1	14.2±5.6	14.2±5.1	15.2±5.0	14.8±5.6
8	13.8±2.9	13.6±6.1	13.7±5.5	17.1±5.9	16.6±5.3	16.8±5.2
9	13.2±2.9	16.6±6.5	15.2±3.4	16.7±5.4	16.6±5.2	16.6±6.4
10	14.2±7.2	12.3±4.7	12.9±3.6	16.8±4.0	17.8±6.4	17.3±5.6
11	14.6±5.0	13.7±5.5	14.0±3.6	16.3±3.3	16.0±6.5	16.1±4.9
12-14	14.8±2.1	14.8±5.7	14.8±3.2	17.9±5.1	17.2±7.0	17.4±5.5
Total	13.8±4.1	13.9±5.2	13.8±4.8*	15.9±5.6	16.1±4.8	16.1±5.3*

SS – smile stimulation. *$p \leq 0.001$.

Table 3.
Results for the O-soto-otoshi nage-komi and 4-Leg Exercise specific tests in children and adolescents practicing jiu-jitsu of both sexes.

Age (years)	Female	Male	Total	Female	Male	Total
	O-soto-otoshi nage-komi test (repetitions)			O-soto-otoshi nage-komi test SS (repetitions)		
3-5	11.5±2.7	9.3±4.6	10.0±4.1	14.2±4.0	14.1±4.2	14.1±4.0
6	10.9±2.8	11.4±4.0	11.2±3.6	13.7±2.5	15.2±5.7	14.6±4.7
7	11.2±2.6	11.9±2.3	11.7±2.4	14.3±3.4	14.2±2.4	14.3±2.8
8	12.4±3.5	12.2±3.5	12.3±3.5	14.2±3.0	14.5±2.2	14.4±2.5
9	11.7±4.1	13.6±3.7	12.8±3.9	15.7±4.1	16.5±3.0	16.1±3.5
10	13.3±3.4	12.2±4.4	12.5±4.1	15.8±3.0	14.8±3.1	15.1±3.0
11	13.1±1.1	13.5±3.9	13.3±3.2	16.8±4.7	15.5±3.2	15.9±3.7
12-14	14.3±2.6	16.8±3.1	15.5±3.1	16.8±3.1	17.7±3.7	17.2±3.4
Total	12.4±3.2	12.6±4.0	12.5±3.7*	15.2±3.6	15.2±3.5	15.2±3.5*
Age (years)	4-Leg Exercise (repetitions)			4-Leg Exercise SS (repetitions)		
3-5	2.2±0.8	2.1±1.0	2.1±0.9	4.1±0.8	4.2±0.9	2.9±1.2
6	1.7±0.7	2.2±1.0	2.0±0.9	3.4±0.8	3.8±1.4	3.0±1.0
7	1.9±0.9	2.5±1.0	2.3±1.0	3.8±1.6	3.5±1.2	3.2±1.2
8	2.4±1.0	2.2±1.0	2.3±1.0	3.7±1.2	3.8±1.1	3.2±1.4
9	3.6±1.4	3.4±1.1	3.5±1.2	3.1±1.4	3.3±1.4	3.8±1.1
10	3.2±0.8	2.8±1.3	2.9±1.2	3.2±1.1	3.3±1.2	3.6±1.3
11	2.8±0.6	3.6±1.5	3.3±1.3	2.5±0.5	3.3±1.2	3.7±1.2
12-14	3.2±0.8	4.2±1.1	3.6±1.1	3.2±1.2	2.8±1.2	4.1±0.8
Total	2.8±1.1	2.8±1.3	2.8±1.2*	3.4±1.2	3.5±1.2	3.5±1.2*

SS – smile stimulation. *$p<0.001$.

For these two measures, better results were observed after children received smile stimuli [*O-soto-otoshi nage-komi:* 2.7 (0.6; 6.9) rep.; 4-Leg Exercise: 0.7 (0.0; 1.1); p≤0.001 for all comparison]. Figure 5 presents the results for the execution of *Gyaku-tsuki* test.

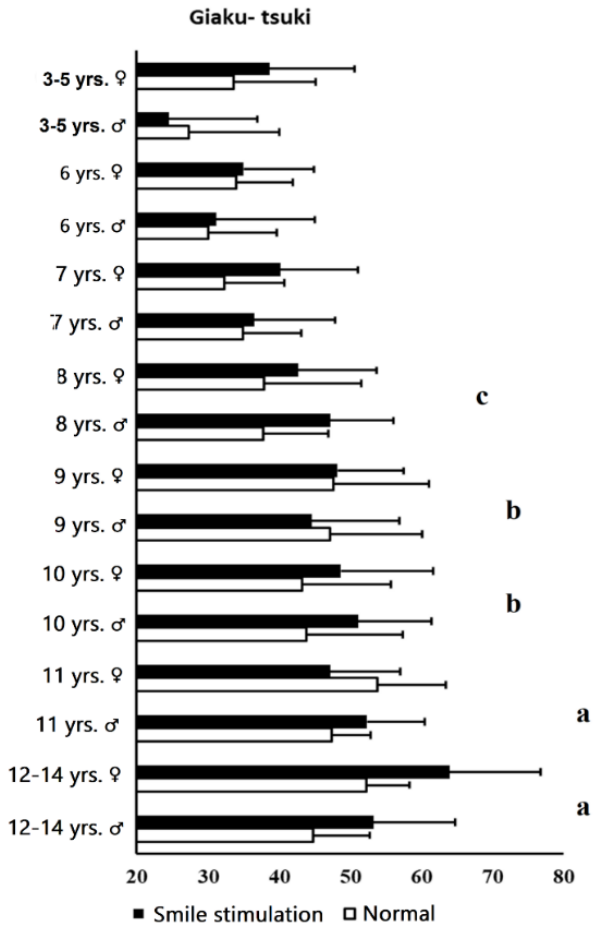

Figure 5. Results for *Gyaku-tsuki* test in both sexes with or without smile stimulation. [a]p≤0.001: 11 and 12-14 age groups vs. 8, 7, 6, 5-3 age groups; [b]p≤0.001: 9 and 10 years vs. 7, 6, 5-3 years; [c]p≤0.035: male children aged 8 years vs. 6 and 3-5 age groups.

There was an interaction effect between stimulation and age (F=3.425; ηp2=0.087; p=0.02). Inferential analyzes indicated that for both sexes, after the joy stimulus, the age group 11 and 12-14 differed from children aged 8, 7, 6, 5-3 years (p≤0.001 for all comparisons); and children aged 9 and 10 differed significantly from those aged 7, 6 and 3-5 (p≤0.001 for all comparisons). In addition, male children aged 8 years differed significantly from those aged 6 and 3-5 years (p≤0.035).

Discussion

There is no clarity in the literature regarding the effect of positive emotions on athletic performance (Rathschlag & Memmert, 2013; Woodman et al., 2009), and there is also a lack of studies with children and adolescents. Thus, the present study measured the performance of children and adolescent's jiu-jitsu practitioners in specifics and non-specifics tests in two conditions: a) when they performed the tests without any prior stimulus and; b) when they were encouraged to smile before taking the tests. The main results indicated that the stimulation of smile had a positive effect on the performance of non-specific tests (Side jumps and Burpees) and specific tests (*O-soto-otoshi nage-komi* and 4-Leg Exercise) (Tables 2 and 3). For the *Gyaku-tsuki* test there was a positive effect of smile stimulation only in the interaction with age, where older athletes performed better (Figure 4). Finally, in general, it is noteworthy that sex was not a variable that interfered with performance. Previously, Philippen, Bakker, Oudejans, & Canal-Bruland (2012) observed that runners who express a smile tend to have a lower subjective perceived of exertion when undergoing a cycle ergometer test (50-60% of heart rate reserve). Our protocol sought to move in another direction by provoking happiness stimuli in our participants.

Although there is no consensus, it seems that positive emotions contribute to better sports performance. A systematic review indicated that by developing positive emotions in the athlete, it becomes possible to motivate them to obtain the best performance in a test (Peris-Delcampo et al., 2024). Furthermore, an athlete's joy can improve the performance of other teammates (Moll, Jordet, & Pepping, 2010). Our results partially agree with those presented by Rathschlag & Memmert (2013), who observed the effects of positive emotions on the performance of sprint runners. Similarly, Brick, McElhinney, & Metcalfe (2018) observed that smiling stimulation results in economy of movement in vigorous-intensity runs and a lower perceived exertion compared with runners who frown. Already, Woodman et al. (2009) did not observe an effect of happiness on strength performance, in contrast to our results, better strength performance was observed when anger stimuli occur, especially in extraverts athletes. Possibly, both happiness and anger can produce positive effects on sports performance. According to Rathschlag & Memmert (2013) better results in the countermovement jump (jump height) when participants were happy or angry compared to those who were neutral or anxious. In addition to the previously published results, our study also had a positive effect of smiling in exercises that required technical domain from the participants (Table 3 and Figure 4). Future studies may or may not confirm the results observed here. In our opinion, there is a long way to go to better understand the effect of positive emotions on fighters' performance. To the best of our knowledge, only the study of Yang, Wen, & Xu (2020) investigated the effect of positive emotions on the performance of Sanda athletes, the results of this study showed that positive emotions have a positive correlation with performance in this combat sport, being an important factor for controlling pre-competitive anxiety. There was no effect of gender on performance in any of our tests, and only in Gyaku Tsuki was there an effect for age, where children and adolescents over 8 years old showed better performance. There are several factors that can influence the physical performance of children and adolescents. In a meta-analysis, that included tests carried out between the

3-20 yrs. old, Thomas & French (1985) observed that age is a determining factor for performance in activities involving skills such as balance, catching, grip strength, shuttle run, throw velocity, tapping (older showed better performance), when analyzed together gender and age, there was an interaction effect for the following tests: sit-ups, long jump, grip strength, and shuttle run (moderate effect sizes: 0.2-0.5), where older men performed better. Our data corroborate the findings of Krombholz (2006) when analyzing the performance of children aged 3-7 years, small differences were observed between physical performance over the years, regardless of gender. The heterogeneity of results may be related to aspects of muscular maturity, which are neglected in many studies since analyzes are carried out by age groups, another factor that can also interfere with the physical performance of children and adolescents may be associated with sexual dysmorphia (Armstrong, Barker, & McManus, 2015). The data from our study corroborate existing data in the literature, as they demonstrated that there are benefits obtained from facial expressions of joy in the specific and non-specific jiu-jitsu physical. It is important to understand whether these benefits occur for any type of sports practice, therefore, more studies on the topic must be developed. Furthermore, it would be interesting if physiological analyzes were carried out to understand whether these benefits have a purely psychological character, related to less perceived effort, or whether there are changes in hormonal levels, such as endorphins.

Conclusion

The field of study on the effects of smiling on performance is innovative and deserves greater dedication. This study provides data that contributes to the understanding of the association between feelings of joy and improved performance, as stimulating emotions of happiness brought better performance to children and adolescents practicing jiu-jitsu. The data showed that this benefit occurred regardless of sex and age, except for the *Gyaku-tsuki* test, for which the older showed the better performance.

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