

Acute psychological, perceptual, recovery, and heart-rate responses to numerical equality and offensive numerical superiority in professional futsal small-sided games

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Abstract

Objectives: To compare acute psychological, perceptual, recovery, and heart-rate responses to 2 vs. 2 versus 2 vs. 2 + 1 small-sided futsal games.

Methods: Sixteen professional male futsal players completed both formats, 48 h apart, in a non-randomized repeated-measures crossover. Each session included three 4-min sets separated by 3-min passive recovery. State anxiety and mood were assessed pre/post; perceived recovery pre; affective valence and enjoyment post; and mean heart rate across sets. Generalized Estimating Equations tested condition, moment/set, and interaction effects.

Results: Condition effects were not detected for state anxiety (Wald $\chi^2=0.137$, $p=0.711$), mood dimensions (all condition/moment/interaction $p\geq 0.080$), affective valence ($\chi^2=0.134$, $p=0.714$), enjoyment ($\chi^2=0.638$, $p=0.424$), or perceived recovery ($\chi^2=0.516$, $p=0.472$). State anxiety decreased pre-to-post regardless of format (30.84 to 28.97 a.u.; MD=1.88, 95% CI 0.22–3.53; $\chi^2=4.925$, $p=0.026$). Heart rate showed no main effects of condition ($\chi^2=3.285$, $p=0.070$) or set ($\chi^2=0.411$, $p=0.814$), but a condition $\times$ set interaction ($\chi^2=12.567$, $p=0.002$), driven by lower set-1 values in 2 vs. 2.

Conclusions: Adding a floater did not detectably alter acute psychological or perceptual responses. Both formats were accompanied by a modest reduction in state anxiety, although the non-randomized order and small single-team sample limit causal inference.

Introduction

Mental health is a relevant concern in adult populations, and participation in sport has been associated with psychological and social benefits across different populations, however, the strength and nature of this evidence vary according to age group and study design^{1,2}. In children and adolescents, participation in organized sport has been linked to psychosocial health indicators, including social integration and perceived well-being¹. In adults, systematic reviews indicate that sport participation is associated with improved mental health outcomes, including reduced symptoms of anxiety and depression and enhanced social functioning². Therefore, although a general positive relationship between sport participation and mental health is supported, psychological responses to sport may vary according to contextual, interpersonal, and task-related factors, including the type of sport, competitive environment, and specific characteristics of the training experience^{2,3}. Within this context, team sports appear to provide additional psychosocial benefits when compared with individual forms of physical activity, as they involve cooperation, shared goals, and social interaction, all of which contribute to psychological functioning and well-being^{3,4}.

However, these benefits are not solely determined by participation per se, but also by how the sport experience is structured in practice, particularly in training contexts where the organization of tasks may shape athletes' physical, cognitive, and emotional responses to exercise^{5,6}. In this context, understanding how different training formats influence not only performance-related outcomes but also athletes'

subjective experience becomes a relevant issue in sport science, as variations in game structure may alter enjoyment, perceptual demands, and acute psychological responses^{7,8}.

From a training perspective, small-sided games have become a central methodological approach in team sports because they preserve key elements of formal competition while allowing systematic manipulation of task constraints, thereby enabling practitioners to align training stimuli with specific technical, tactical, and physical objectives^{9,10}. One of the main strengths of small-sided games lies in their ecological validity, as they simultaneously integrate perceptual, decision-making, and motor demands within a representative task environment, which has been shown to facilitate skill acquisition and performance development^{5,11}. Accordingly, the effects of small-sided games are largely determined by how the task is structured, rather than by the mere use of a game-based format, since manipulations in constraints such as player number, pitch size, and numerical relations alter the demands imposed on performers and the range of available action possibilities^{5,12}.

Among these constraints, the number of players and the relative playing area have consistently been identified as key variables influencing physical, physiological, and behavioral responses, with evidence showing that reductions in player number increase individual involvement and intensity, while larger playing areas increase locomotor demands and external load^{11,12}. Similarly, numerical superiority has been shown to influence not only physical demands but also tactical organization and perceptual load, as the presence of an additional player alters passing options, spatial occupation, and decision-making requirements^{6,13}. These findings indicate that structural changes in game format do not simply adjust workload but fundamentally reorganize the task's interaction dynamics, thereby modifying how players engage with teammates, opponents, and space during play^{5,6}.

This issue is particularly relevant in futsal, a sport characterized by high-intensity intermittent actions, limited playing space, rapid transitions, and frequent technical involvement, where small variations in task structure can substantially influence both performance demands and player experience^{14,15}. In such a context, manipulations involving numerical equality and superiority are especially meaningful because they directly affect the balance between individual responsibility and collective support, potentially influencing not only physical load but also cognitive and perceptual demands during play^{6,13}.

Despite the consistency of the literature regarding physical, physiological, and tactical responses to small-sided games, the psychological dimension remains comparatively underexplored, and existing syntheses indicate that psychological outcomes have been investigated less frequently than other domains in training research^{4,10}. More specifically, previous reviews suggest that when psychological variables are examined in small-sided games, they are often limited to enjoyment or perceived exertion, with less attention given to broader constructs such as anxiety, mood states, and affective responses^{7,10}.

This limitation is relevant because psychological responses are an integral component of how athletes experience training stimuli, and constructs such as state anxiety, mood, and affective valence provide important information about the acute impact of exercise beyond traditional markers of load and performance^{16,17}. In futsal specifically, the available literature has identified a range of psychological

constructs associated with performance and participation; however, it does not provide a consolidated understanding of how different small-sided game configurations acutely influence psychological responses^{4,16}.

This gap becomes particularly relevant when comparing formats such as 2 vs. 2 and 2 vs. 2+1, because the inclusion of a floater player alters numerical relations and increases support options, which may reduce individual pressure, whereas formats played in numerical equality may increase individual exposure and task demands^{6,13}. Although current evidence more strongly supports the impact of these manipulations on physical, perceptual, and tactical variables, the constraints-based training framework suggests that such structural changes may also influence athletes' subjective and psychological responses during exercise^{5,12}.

Therefore, investigating psychological responses, such as state anxiety, mood, affective valence, and enjoyment, across different small-sided game formats may contribute to a more comprehensive understanding of training effects in futsal, extending the literature beyond its predominantly physiological and tactical focus^{10,16}. Although small-sided games are primarily used as sport-specific training tasks, their relevance also extends to exercise-related health research because they combine high physiological engagement with social interaction, decision-making, and affective experience. Examining whether subtle changes in game structure modify anxiety, mood, affective valence, and enjoyment may therefore clarify how exercise tasks can be organized to preserve positive psychological responses while maintaining physiological stimulation. Accordingly, the present study aimed to compare acute state anxiety, mood, affective valence, enjoyment, perceived recovery, and mean heart-rate responses between 2 vs. 2 and 2 vs. 2 + 1 small-sided games in adult futsal players. Based on evidence indicating that manipulations of player number, spatial configuration, and numerical superiority modify the demands imposed on players, it was hypothesized that the two formats would elicit different acute responses, although the direction and magnitude of these differences were considered exploratory, as psychological responses to futsal small-sided games remain underinvestigated^{11,12}.

Results

For state anxiety, the GEE model specified a normal distribution, identity link, and independent working correlation structure (QIC = 3506.125). There was no main effect of condition, Wald $\chi^2(1) = 0.137$, $p = 0.711$, a main effect of moment, Wald $\chi^2(1) = 4.925$, $p = 0.026$, and no condition $\times$ moment interaction, Wald $\chi^2(1) < 0.001$, $p = 1.000$. Estimated marginal means were 29.69 (95% CI 26.25 to 33.13) for 2 vs. 2 and 30.13 (95% CI 26.70 to 33.55) for 2 vs. 2 + 1. Estimated marginal means were 30.84 (95% CI 27.65 to 34.04) at pre-test and 28.97 (95% CI 25.50 to 32.44) at post-test. Pairwise comparisons indicated lower state anxiety at post-test than at pre-test (mean difference = 1.88, 95% CI 0.22 to 3.53, $p = 0.026$).

For mood, GEE models specified a normal distribution, an identity link, and an independent working correlation structure across all dimensions. For tension, the model showed no main effect of condition, Wald $\chi^2(1) = 0.440$, $p = 0.507$, no main effect of moment, Wald $\chi^2(1) = 2.050$, $p = 0.152$, and no condition $\times$ moment interaction, Wald $\chi^2(1) = 0.613$, $p = 0.434$ (QIC = 443.438). Estimated marginal means were 1.25 (95% CI 0.44 to 2.06) for 2 vs. 2 and 1.53 (95% CI 0.09 to 2.98) for 2 vs. 2 + 1, whereas the estimated

marginal means across moments were 1.59 (95% CI 0.52 to 2.67) at pre-test and 1.19 (95% CI 0.01 to 2.37) at post-test. For depression, there was no main effect of condition, Wald $\chi^2(1) = 0.044$, $p = 0.835$, no main effect of moment, Wald $\chi^2(1) = 1.622$, $p = 0.203$, and no condition $\times$ moment interaction, Wald $\chi^2(1) = 3.075$, $p = 0.080$ (QIC = 93.188). Estimated marginal means were 0.63 (95% CI 0.11 to 1.14) for 2 vs. 2 and 0.59 (95% CI 0.09 to 1.09) for 2 vs. 2 + 1, whereas the estimated marginal means across moments were 0.75 (95% CI 0.18 to 1.32) at pre-test and 0.47 (95% CI -0.02 to 0.96) at post-test. For anger, there was no main effect of condition, Wald $\chi^2(1) = 0.049$, $p = 0.825$, no main effect of moment, Wald $\chi^2(1) = 2.717$, $p = 0.099$, and no condition $\times$ moment interaction, Wald $\chi^2(1) = 0.061$, $p = 0.805$ (QIC = 77.375). Estimated marginal means were 0.41 (95% CI 0.05 to 0.77) for 2 vs. 2 and 0.47 (95% CI 0.06 to 0.88) for 2 vs. 2 + 1, whereas the estimated marginal means across moments were 0.25 (95% CI 0.02 to 0.48) at pre-test and 0.63 (95% CI 0.19 to 1.06) at post-test. For vigor, there was no main effect of condition, Wald $\chi^2(1) = 0.540$, $p = 0.462$, no main effect of moment, Wald $\chi^2(1) = 0.004$, $p = 0.953$, and no condition $\times$ moment interaction, Wald $\chi^2(1) = 1.794$, $p = 0.180$ (QIC = 336.563). Estimated marginal means were 11.00 (95% CI 9.98 to 12.02) for 2 vs. 2 and 10.72 (95% CI 9.84 to 11.60) for 2 vs. 2 + 1, whereas the estimated marginal means across moments were 10.84 (95% CI 9.76 to 11.92) at pre-test and 10.88 (95% CI 9.93 to 11.82) at post-test. For fatigue, there was no main effect of condition, Wald $\chi^2(1) < 0.001$, $p = 1.000$, no main effect of moment, Wald $\chi^2(1) = 0.127$, $p = 0.722$, and no condition $\times$ moment interaction, Wald $\chi^2(1) = 2.327$, $p = 0.127$ (QIC = 665.375). Estimated marginal means were 2.97 (95% CI 1.34 to 4.60) for 2 vs. 2 and 2.97 (95% CI 1.73 to 4.21) for 2 vs. 2 + 1, whereas the estimated marginal means across moments were 2.88 (95% CI 1.69 to 4.06) at pre-test and 3.06 (95% CI 1.65 to 4.48) at post-test. For confusion, there was no main effect of condition, Wald $\chi^2(1) = 0.101$, $p = 0.751$, no main effect of moment, Wald $\chi^2(1) = 0.053$, $p = 0.818$, and no condition $\times$ moment interaction, Wald $\chi^2(1) = 0.203$, $p = 0.653$ (QIC = 203.750). Estimated marginal means were 1.06 (95% CI 0.26 to 1.86) for 2 vs. 2 and 1.00 (95% CI 0.19 to 1.81) for 2 vs. 2 + 1, whereas the estimated marginal means across moments were 1.06 (95% CI 0.27 to 1.86) at pre-test and 1.00 (95% CI 0.15 to 1.85) at post-test.

For affective valence, the GEE model specified a normal distribution, identity link, and independent working correlation structure (QIC = 67.750). There was no main effect of condition, Wald $\chi^2(1) = 0.134$, $p = 0.714$. Estimated marginal means were 3.50 (95% CI 2.88 to 4.12) for 2 vs. 2 and 3.63 (95% CI 2.87 to 4.38) for 2 vs. 2 + 1.

For enjoyment, the GEE model specified a normal distribution, an identity link, and an independent working correlation structure (QIC = 6241.750). There was no main effect of condition, Wald $\chi^2(1) = 0.638$, $p = 0.424$. Estimated marginal means were 110.50 (95% CI 103.61 to 117.39) for 2 vs. 2 and 108.13 (95% CI 101.34 to 114.91) for 2 vs. 2 + 1.

For perceived recovery, the GEE model specified a normal distribution, identity link, and independent working correlation structure (QIC = 144.750). There was no main effect of condition, Wald $\chi^2(1) = 0.516$, $p = 0.472$. Estimated marginal means were 15.25 (95% CI 14.06 to 16.44) for 2 vs. 2 and 14.88 (95% CI 14.05 to 15.70) for 2 vs. 2 + 1.

For mean heart rate, the GEE model specified a normal distribution, identity link, and independent working correlation structure (QIC = 13289.793). There was no main effect of condition, Wald $\chi^2(1) = 3.285$, $p =$

0.070, no main effect of set, Wald $\chi^2(2) = 0.411$, $p = 0.814$, and a significant condition $\times$ set interaction, Wald $\chi^2(2) = 12.567$, $p = 0.002$. Estimated marginal means were 169.59 (95% CI 163.92 to 175.26) for 2 vs. 2 and 174.47 (95% CI 170.05 to 178.89) for 2 vs. 2 + 1. Estimated marginal means across sets were 171.59 (95% CI 168.92 to 174.25) in set 1, 172.53 (95% CI 166.74 to 178.32) in set 2, and 171.97 (95% CI 166.51 to 177.43) in set 3. For the condition $\times$ set combinations, estimated marginal means were 167.02 (95% CI 161.63 to 172.40), 170.75 (95% CI 165.00 to 176.50), and 171.00 (95% CI 164.52 to 177.48) for sets 1, 2, and 3 in the 2 vs. 2 condition, respectively, and 176.16 (95% CI 175.86 to 176.45), 174.31 (95% CI 166.31 to 182.31), and 172.94 (95% CI 167.35 to 178.53) for sets 1, 2, and 3 in the 2 vs. 2 + 1 condition, respectively. Pairwise comparisons indicated that mean heart rate in set 1 of the 2 vs. 2 condition was lower than in set 2 of the same condition (mean difference = -3.73, 95% CI -6.38 to -1.09, $p = 0.006$), lower than in set 3 of the same condition (mean difference = -3.98, 95% CI -7.45 to -0.52, $p = 0.024$), and lower than in set 1 of the 2 vs. 2 + 1 condition (mean difference = -9.14, 95% CI -14.59 to -3.69, $p = 0.001$).

Table 1. Descriptive data of state anxiety, mood, affective valence, enjoyment, and TQR.

Variables		Condition 2 vs. 2		Condition 2 vs. 2 (+1)	
		Average $\pm$ SD		Average $\pm$ SD	
		Pre	Post	Pre	Post
State Anxiety (a.u.)		30.62 $\pm$ 8.10	28.75 $\pm$ 7.28	31.06 $\pm$ 6.50	29.18 $\pm$ 8.49
Mood State (a.u.)	Tension	1.65 $\pm$ 2.47	0.88 $\pm$ 1.26	1.56 $\pm$ 2.36	1.50 $\pm$ 3.96
	Depression	0.87 $\pm$ 1.31	0.38 $\pm$ 1.02	0.62 $\pm$ 1.14	0.56 $\pm$ 1.26
	Anger	0.25 $\pm$ 0.44	0.56 $\pm$ 1.50	0.25 $\pm$ 0.57	0.68 $\pm$ 1.35
	Vigor	10.81 $\pm$ 2.78	11.18 $\pm$ 2.23	10.87 $\pm$ 2.12	10.56 $\pm$ 2.15
	Fatigue	3.12 $\pm$ 3.44	2.81 $\pm$ 3.64	2.62 $\pm$ 2.62	3.31 $\pm$ 3.43
	Confusion	1.12 $\pm$ 1.78	1.00 $\pm$ 1.75	1.00 $\pm$ 1.63	1.00 $\pm$ 2.03
Affective valence (a.u.)			3.50 $\pm$ 1.31		3.65 $\pm$ 1.58
Enjoyment (a.u.)			110.50 $\pm$ 14.52		108.10 $\pm$ 14.31
TQR (a.u.)		15.25 $\pm$ 2.51		14.87 $\pm$ 1.74	

Table 2. Descriptive data of heart rate.

Variable	Condition			Condition		
	2 vs. 2			2 vs. 2 (+1)		
	Average $\pm$ SD			Average $\pm$ SD		
	Set 1	Set 2	Set 3	Set 1	Set 2	Set 3
Heart rate (bpm)	167 $\pm$ 11	170 $\pm$ 12	170 $\pm$ 13	176 $\pm$ 12	174 $\pm$ 16	172 $\pm$ 11

Discussion

The present study investigated whether two futsal small-sided game formats differing in numerical relation, 2 vs. 2 and 2 vs. 2 + 1, would elicit distinct acute psychological responses in professional players. The central finding was that the initial hypothesis was not supported, as no between-condition differences were observed for state anxiety, mood dimensions, affective valence, enjoyment, or perceived recovery, despite manipulations of numerical balance and task constraints, which are known to modify game dynamics and workload characteristics in small-sided games^{5,6,13}. From an ecological dynamics perspective, this result is not trivial. It suggests that structural manipulations may reorganize interaction opportunities within the task without necessarily producing detectable divergence in immediate psychological experience when other key constraints remain stable, such as the playing area per player, session duration, recovery intervals, and the rule framework^{5,10,13}. In practical terms, the data indicate that adding a floater was not associated with statistically detectable changes in the psychological and perceptual outcomes assessed in this sample.

The most robust effect observed in the study was the reduction in state anxiety from pre- to post-session, irrespective of format. This finding deserves interpretive priority because it was the only consistent psychological change detected by the model and, therefore, the clearest answer to the acute question posed by the study. The result is consistent with a broad literature showing that acute exercise tends to produce small but reliable reductions in state anxiety, including systematic reviews and meta-analyses, and more recent syntheses on exercise and anxiety^{18–20}. It is also coherent with the literature, indicating that sport participation, particularly in socially interactive contexts, is associated with favorable mental health correlates and a lower likelihood of anxiety and depressive symptoms when compared with less socially embedded forms of participation^{2–4}. Accordingly, the present data suggest that, at least in a pre-competitive applied setting, these futsal small-sided games were not associated with acute worsening of psychological responses and were accompanied by a modest reduction in state anxiety.

A more nuanced interpretation is that the anxiolytic response was format-independent because both tasks preserved the core experiential properties most likely to influence anxiety acutely: repeated involvement, externally directed attention, high representativeness, and continuous cooperative-competitive interaction. Small-sided games are designed to preserve the informational and decision-making couplings that characterize formal play while maintaining high engagement with the ball, teammates, opponents, and space^{5,10}. In that sense, even though numerical superiority changes passing options and interaction structure, both formats may still share the same essential attentional and action demands from the players' perspective, thereby generating a broadly similar psychological response^{5,6,13}. This interpretation is

particularly plausible in professional players, whose familiarity with representative game-based tasks may reduce the probability that modest changes in numerical structure translate into marked subjective disturbance. That inference should be treated cautiously, but it is consistent with the absence of condition effects across all measured psychological outcomes in the present dataset.

The absence of significant effects for tension, depression, anger, vigor, fatigue, and confusion is also informative and should not be reduced to a merely null result. In applied sport science, mood stability under demanding practice conditions can be meaningful, especially during the pre-competitive phase, when maladaptive emotional fluctuations would be undesirable. The literature on psychological variables in futsal and football indicates that anxiety, stress, motivation, coping, and mood-related constructs are relevant to performance environments, but also that psychological outcomes remain comparatively less investigated and less consistently responsive than physiological, technical, and tactical outcomes in the small-sided games literature^{4,10,16}. Therefore, the present findings support the interpretation that brief manipulations from 2 vs. 2 to 2 vs. 2 + 1 may be insufficient to perturb acute mood state in experienced players when the broader session architecture is highly controlled. Rather than indicating a lack of psychological relevance, this pattern suggests that the athletes tolerated both formats without measurable deterioration in emotional tone, vigor, or confusion-related states.

The findings for affective valence and enjoyment reinforce this same interpretive direction. Both formats were experienced positively, and neither produced superior pleasure or enjoyment over the other. This is important because affective valence and enjoyment are not peripheral variables in training design; rather, they are part of the immediate experiential quality of the task and can shape willingness to engage, perceived acceptability, and the broader psychosocial tone of practice^{2,4,7}. The current results suggest that when training is delivered through representative game forms, the overall experiential value of the task may remain high even when numerical relations are adjusted. Put differently, the game-based nature of the session may have been more decisive for positive subjective experience than the specific difference between equality and superiority. That reading is compatible with evidence that small-sided games are generally perceived as enjoyable training modalities and that psychological responses in these contexts are often more clearly distinguished when game-based methods are contrasted with non-game-based interval conditioning, rather than when two representative game formats are compared against each other^{2,7,10}.

The heart-rate results add an important layer to the interpretation, showing that physiological and psychological patterning were not isomorphic in the present study. Although there was no overall main effect of condition or set, the significant condition × set interaction indicates that cardiovascular behavior was not identical across the two formats over time, with set 1 of the 2 vs. 2 condition showing a lower mean heart rate than later sets in the same format and than set 1 of the 2 vs. 2 + 1 format. This aligns with the broader small-sided games literature, which shows that internal load can be altered by manipulations in numerical balance, relative playing area, and tactical organization, although these effects are often context-sensitive rather than uniform across designs^{6,12,13,21}. The key point, however, is that differences in anxiety, mood, valence, or enjoyment did not mirror these bout-related physiological differences. For applied interpretation, this dissociation is valuable: it indicates that modest shifts in cardiovascular response do not automatically imply a parallel shift in acute psychological experience. Coaches should therefore avoid

assuming that internal-load variation between closely related game formats will necessarily translate into more negative or more positive subjective responses, particularly in trained adult players.

Taken together, the findings suggest that the observed psychological responses showed no statistically detectable differentiation between formats. This is arguably the most defensible high-level conclusion from the data. The manipulation from 2 vs. 2 to 2 vs. 2 + 1 changed the formal numerical relation of the task, but did not meaningfully alter the athletes' acute psychological profile. At the same time, both formats were associated with a reduction in state anxiety and were experienced with similarly positive affective valence and enjoyment. Within the still-limited literature on psychological responses to futsal-related training tasks, this is a relevant contribution because it helps refine expectations: coaches may choose between these formats primarily on tactical, pedagogical, or load-management grounds rather than on the assumption that one will inherently produce a clearly more favorable acute psychological response^{4,10,16}. In that sense, the present study extends the literature beyond the usual physiological and tactical emphasis. It indicates that, under controlled applied conditions, representative futsal games may preserve positive subjective experience even when their interaction structure is moderately altered.

Given several constraints, the study should be interpreted with caution. Because the order of the two formats was not randomized, order and familiarization effects cannot be excluded. Therefore, the absence of between-format psychological differences should be interpreted as evidence of no detectable difference under the present applied sequence, rather than as definitive equivalence between formats. First, the sample consisted of athletes from a single professional team, which limits external validity and reduces confidence that the same pattern would necessarily emerge at other competitive levels, developmental stages, or tactical cultures. Second, the modest sample size limits statistical precision, especially for detecting subtle psychological differences between closely related formats. Third, the study examined only acute responses, so the results cannot be extended to cumulative psychological adaptations across training weeks or competitive microcycles. Fourth, the psychological outcomes were self-reported, which is appropriate for constructs such as anxiety, mood, affective valence, and enjoyment, but also leaves the data dependent on response accuracy and contextual state at the moment of measurement. Fifth, although the heart-rate interaction suggests some physiological differentiation between formats, the absence of complementary external-load and behavioral indicators limits the mechanistic interpretation of why that pattern emerged. Future studies should examine larger samples, randomized or counterbalanced format orders, repeated exposures, and integrated psychological, physiological, and tactical profiling in futsal-specific small-sided games.

Methods

Sample

The sample consisted of 16 male futsal players recruited by convenience from a competitive team based in the state of Goiás, Brazil. The athletes had a mean age of 24.81 ± 5.09 years, height of 179 ± 6.2 cm, and body mass of 77.23 ± 10.42 kg. Although the sampling procedure was non-probabilistic, the inclusion of this team provided access to a high-performance applied context, as the athletes were members of the Goiás

state champion team and regularly engaged in structured training and competitive routines. No a priori sample-size calculation was performed. The sample size was determined by the number of eligible professional players available on the team during the pre-competitive period. The repeated-measures crossover structure reduced between-subject variability but does not eliminate the limitations associated with the modest sample size. This approach was considered appropriate for the study, which required participants with systematic exposure to futsal-specific training demands. No adverse events occurred during the study sessions.

All players participated in at least 3 training sessions per week and had at least 2 years of competitive futsal experience. Data collection was conducted during the pre-competitive period of the 2025 season. Players were eligible if they were free from injury at the time of data collection and reported no physical or psychological conditions that could limit full participation in training sessions. Additionally, all participants provided written informed consent before participation. Exclusion criteria included failure to complete the questionnaires on the assessment days and absence from either experimental session. No participants were excluded after eligibility screening, and no losses occurred during the study period. All participants completed both experimental sessions and all outcome assessments as planned. Because the sample consisted of professional futsal players regularly engaged in structured training routines, full adherence to the intervention protocol was observed throughout the study period.

Experimental approaches

This study followed a quasi-experimental, repeated-measures crossover design to examine the acute psychological, perceptual, and physiological responses of professional futsal players to two small-sided game formats (2 vs. 2 and 2 vs. 2 + 1). Reporting followed the TREND statement for nonrandomized evaluations, with explicit description of participant eligibility, recruitment, assignment to conditions, intervention content, outcome timing, statistical modeling, missing data, and limitations related to nonrandom allocation. The TIDieR checklist was additionally used to improve the replicability of the small-sided game protocols. Because of the applied nature of the intervention and the visible differences between game formats, blinding of participants and researchers was not feasible. Intervention fidelity was supported by maintaining the same session structure, official futsal rules, playing area per player, recovery intervals, time of day, and supervision procedures across both formats. The study was approved by the Research Ethics Committee of the Federal University of Goiás (Universidade Federal de Goiás, Brazil) under protocol CAAE 65290217.2.000.5083. All procedures were conducted in accordance with the Declaration of Helsinki and its subsequent amendments. Written informed consent was obtained from all participants prior to participation. All data were anonymized before analysis, and only the research team had access to the analytical dataset.

Experimental design and interventions

Participants completed both conditions on separate days, with a 48-hour interval between sessions. The order of the conditions was not randomized. To minimize imbalance between teams, the coaching staff ranked players and assigned them to pairs of similar competitive level. Each pair included at least one wing player and one player in either the fixo or pivot position. In the 2 vs. 2 + 1 format, the floater always played

with the team in possession, creating temporary offensive numerical superiority. The floater role in the 2 vs. 2 + 1 condition was performed by two external players who were not part of the analytical sample and who played as wings. The floater was allowed to score.

Both small-sided game formats were performed under the same contextual conditions. Each session lasted 18 minutes and was divided into three 4-minute sets interspersed with 3-minute passive recovery periods. A standardized warm-up was completed before both sessions and consisted of passive stretching, locomotor activities, and ball-based exercises. Official futsal rules were adopted in both formats, and the playing area per player was maintained at 85.5 m². All sessions were conducted at the team's regular training venue, the Universo Gymnasium, in Goiânia, Goiás, Brazil, at the same time of day and under similar environmental conditions.

Data collection was carried out during the pre-competitive period, 15 days before the competition, within the team's regular training schedule, from 9:00 p.m. to 11:00 p.m. State anxiety and mood state were assessed immediately before and after each session. Perceived recovery status was assessed only before each session. Affective valence and enjoyment were assessed only after each session. Mean heart rate was recorded throughout each of the three sets. Because the order of conditions was not randomized, potential order effects cannot be ruled out and were considered in the interpretation of the findings.

Outcome Measures

Psychological and perceptual outcomes were assessed using validated instruments widely applied in sport and exercise psychology, with established reliability and validity for assessing acute responses to exercise and training stimuli.

State anxiety was assessed using the State subscale of the State-Trait Anxiety Inventory, which measures transient anxiety responses associated with situational demands. The instrument consists of 20 items rated on a 4-point Likert scale ranging from "not at all" to "very much so," with total scores ranging from 20 to 80. Higher scores indicate greater anxiety. The STAI has been extensively validated and is sensitive to acute fluctuations in anxiety in sport and exercise contexts²².

Mood state was evaluated using the Brunel Mood Scale (BRUMS), which comprises 24 items distributed across six dimensions: tension, depression, anger, vigor, fatigue, and confusion. Each item is rated on a 5-point Likert scale ("not at all" to "extremely"), with subscale scores ranging from 0 to 16. The BRUMS has demonstrated robust psychometric properties in athletic populations and is sensitive to acute mood changes induced by exercise^{17,23}.

Affective valence was measured using the Feeling Scale, a single-item scale ranging from -5 (very bad) to +5 (very good), designed to capture the pleasure–displeasure dimension of affective response during and after exercise. This measure is widely used due to its sensitivity to acute affective changes and its strong theoretical grounding in dual-mode theory²⁴.

Enjoyment was assessed using the Physical Activity Enjoyment Scale, composed of 18 items rated on a 7-point Likert scale. Total scores reflect the degree to which the activity is perceived as enjoyable and

intrinsically motivating. PACES has demonstrated strong reliability and validity across different populations and is widely used to assess hedonic responses to physical activity^{25,26}.

Perceived recovery status was assessed using the Total Quality Recovery Scale at the start of each session. The scale ranges from 6 to 20, with higher scores indicating better recovery and readiness. The TQR is conceptually analogous to the Rating of Perceived Exertion but applied to recovery perception and has been widely used in training monitoring²⁷.

Physiological responses were assessed by continuously recording mean heart rate during each set using Polar H10 heart-rate monitors (Polar Electro Oy, Kempele, Finland). Data were sampled at 5-second intervals and averaged per set, providing an internal load indicator. Heart rate monitoring is a well-established method for quantifying exercise intensity and internal training load in team sports^{28,29}.

Data analysis

All analyses were performed using Generalized Estimating Equations, given the repeated-measures and crossover structure of the data and the need to account for within-subject correlation across observations. Separate GEE models were specified for each outcome based on its measurement structure. In all models, participants were treated as the subject variable, a normal distribution with an identity link function was adopted, and an independent working correlation structure was specified. Robust standard errors were used for parameter estimation. Model fit was inspected using the Quasi-likelihood under the Independence Model Criterion. Statistical significance was set at $p \leq 0.05$, and all analyses were conducted in IBM SPSS Statistics for Windows, version 26.0. For state anxiety and each mood dimension, participants contributed 4 observations across 2 conditions and 2 time points. Accordingly, GEE models included condition (2 vs. 2; 2 vs. 2 + 1), moment (pre; post), and the condition $\times$ moment interaction as fixed effects. When significant main or interaction effects were identified, least significant difference pairwise comparisons were performed to examine pairwise differences. For perceived recovery status, affective valence, and enjoyment, participants contributed one observation per condition. Therefore, these outcomes were analyzed using GEE models, with condition as the fixed effect and participant as the repeated subject factor. Because these variables were not assessed at both pre- and post-session time points, no moment effects or condition $\times$ moment interactions were tested for these outcomes. For the mean heart rate, participants contributed 6 observations across 2 conditions and 3 sets. Heart rate was therefore analyzed using GEE models including condition, set, and the condition $\times$ set interaction as fixed effects. Because a set represents an ordered repeated factor, the analysis also allowed examination of the temporal pattern of heart rate across the three sets.

Declarations

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Author contributions statement

A.C.R.R. conceived the study, designed the experimental procedures, conducted the data collection, organized the database, performed the initial analyses, and drafted the manuscript. A.S.S.F. contributed to data collection, methodological procedures, and revision of the manuscript. L.L. contributed to the methodological design, interpretation of the findings, and critical revision of the manuscript. J.C.P.C. contributed to the study design, supervision of data collection procedures, and critical revision of the manuscript. F.M.C. contributed to the conceptual framework, methodological supervision, interpretation of results, and critical revision of the manuscript. M.H.C. contributed to the interpretation of the findings and to the manuscript revision. V.A. contributed to data interpretation and critical revision of the manuscript. C.A.V. contributed to methodological discussions and manuscript revision. C.G. contributed to the interpretation of the results and critical revision of the manuscript. R.M.S. contributed to the conceptual interpretation of the findings and manuscript revision. R.T. contributed to methodological interpretation and critical revision of the manuscript. M.N. contributed to statistical analysis, data interpretation, and manuscript revision. G.D.C.T.C. supervised all stages of the study, contributed to the study conception and design, interpreted the findings, critically revised the manuscript, and approved the final version for submission. All authors reviewed and approved the final manuscript.

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Ethics Statement

The study was approved by the Research Ethics Committee of the Federal University of Goiás (Universidade Federal de Goiás, Brazil) under protocol CAAE 65290217.2.000.5083. All procedures were conducted in accordance with the Declaration of Helsinki and its subsequent amendments. Written informed consent was obtained from all participants prior to participation.

Additional information

Competing interests: The authors declare no competing interests.

Data availability: The datasets generated and/or analyzed during the current study are available as Supplementary Information files.

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Figures

Study Design: Small-Sided Futsal Games

48-HOUR INTERVAL BETWEEN SESSIONS

2 vs. 2 Condition



2 vs. 2 Format

2 vs. 2 + 1 Condition



2 vs. 2 + 1 Format with Floater

Standardized Warm-Up



Pre-Session Measures

- Perceived Recovery
- State Anxiety & Mood State



Mean Heart Rate Recorded During Sets

Post-Session Measures

- Affective Valence
- Enjoyment
- State Anxiety & Mood State

Pre-Competitive Period: 9:00 PM – 11:00 PM, 15 Days Before Competition

Figure 1

Experimental design

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [GEEFutsalnew.xlsx](#)
- [RawData.xlsx](#)