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論文の内容の要旨

Spectator engagement and excitement are fundamental to the global appeal and sustained success of competitive sports. The interplay between game structure, scoring dynamics, and underlying psychological mechanisms significantly influences the cognitive and emotional experiences of both players and spectators. Previous research utilizing Game Refinement (GR) theory and the Motion in Mind (MiM) model has provided valuable insights into how gameplay characteristics, such as game length and scoring frequency, broadly affect spectator engagement. However, less analytical attention has been paid to the nuanced differences between high-scoring and low-scoring sports, the unique structural characteristics across sporting formats, the dynamics of uncertainty resolution, distinct phases within matches, and competitive interactions between opposing teams or players. Sports inherently vary in their scoring frequency and strategic rhythms; for instance, high-scoring sports like cricket (ODI and T20 formats) feature frequent reinforcing events that sustain continual engagement, whereas low-scoring sports such as soccer rely on rare yet intensely impactful scoring events to heighten excitement. Thus, systematically examining these inherent differences including structural variations, phase-specific engagement patterns, and competitive intensity and understanding their psychological foundations are critical for advancing theoretical insights and practical strategies aimed at optimizing spectator experience. This research integrates and expands existing frameworks to explicitly analyze these diverse aspects, providing a comprehensive and nuanced theoretical modeling of engagement and excitement dynamics across varied sporting contexts.

Despite considerable progress in understanding the general factors influencing spectator engagement and excitement, critical gaps remain in the current analytical frameworks. Existing studies predominantly focus on holistic game-level analysis, often neglecting how variations in scoring structures (high-scoring versus low-scoring), temporal segmentation (distinct phases within

matches), and competitive interactions between opposing teams or players uniquely shape the spectator's cognitive and emotional experience. In particular, limited attention has been paid to systematically comparing sports with inherently different scoring frequencies and strategic dynamics, such as cricket and soccer, or exploring how psychological engagement and excitement evolve dynamically across different phases of a match. Furthermore, existing models have not explicitly quantified the nuanced competitive interactions between teams or players that significantly influence perceived fairness, strategic intensity, and overall spectator enjoyment. These analytical oversights restrict our understanding of how specific structural and competitive elements interact to sustain and enhance spectator engagement and excitement. Addressing these gaps is essential for developing comprehensive theoretical models and practical guidelines capable of optimizing sports structures and enhancing spectator experiences across diverse sporting contexts.

This research aims to bridge these analytical gaps by systematically exploring how variations in scoring structure, game segmentation, and competitive interactions influence spectator engagement and excitement dynamics across different sporting contexts. Specifically, it comparatively analyzes the psychological mechanisms underlying spectator engagement in sports with inherently different scoring frequencies and structural characteristics, contrasting high-scoring formats (ODI and T20 cricket) with a low-scoring format (soccer). Furthermore, the research examines how distinct game phases such as opening, middle, and endgame, uniquely shape cognitive load, emotional intensity, and spectator excitement, offering a detailed phase-based understanding of engagement dynamics. Additionally, the study develops and empirically validates a novel, gravity-inspired analytical framework that explicitly quantifies competitive interactions, capturing intensity, balance, and strategic positioning between opposing teams or players. By addressing these objectives, this research advances theoretical frameworks, deepens insights into spectator psychology, and provides actionable recommendations to optimize game structures and competitive balance, ultimately enhancing spectator enjoyment across diverse sporting environments.

This research employed an integrative methodological framework combining the Game Refinement (GR) theory, Motion in Mind (MiM), and Flow in Mind (FiM) analytical models to systematically analyze engagement and excitement dynamics across cricket (ODI and T20) and soccer. Comprehensive datasets were collected from major international tournaments, the ICC ODI Cricket World Cup 2023, ICC T20 Cricket World Cup 2022, and FIFA World Cup 2022. Cricket matches were analyzed through detailed ball-by-ball data, while soccer matches were examined using minute-by-minute records, allowing fine-grained segmentation of games into distinct phases (opening, middle, and endgame). A novel, gravity-inspired analytical framework based on gravitational principles was developed to explicitly quantify competitive interactions, measuring competitive

intensity, force of attraction, and potential advantage. This integrative and multi-layered analytical approach enabled robust comparative analysis across high- and low-scoring sports, distinct gameplay phases, and direct competitive interactions, providing nuanced theoretical insights and practical implications.

Keywords:

Cricket and Soccer, Engagement and Excitement Dynamics, Phase-based Analysis, Game Refinement Theory, Motion in Mind (MiM) and Flow in Mind (FiM) Models, Gravitational Analogy.

論文審査の結果の要旨

本博士論文では，ゲーム洗練度理論（Game-refinement theory），思考の世界の力学（Motion in Mind），心の重力モデルに基づくフロー（Flow in Mind）の分析モデルを統合した方法論的枠組みを提案し，高得点タイプのクリケット（ODI と T20）と低得点タイプのサッカーを題材として没入感と興奮の動態について体系的分析を試みた．それぞれのスポーツ競技に対して，主要な国際大会から包括的なデータセットを収集し，心の重力モデルに基づく革新的な分析フレームワークを用いて，チーム間の競争的相互作用の定量化を試みた．この統合的で多層的な分析アプローチにより，高得点スポーツと低得点スポーツ，異なるゲームプレイフェーズ，直接的な競争的相互作用を横断した堅牢な比較分析を実現し，理論的洞察と実践的な示唆を提供した．こうして，競争性の度合い，競争的引力の強さ，潜在的な優位性の測定が可能となった． 本研究は，得点構造，ゲームセグメンテーション，競争的相互作用の差異が，異なるスポーツの文脈において観戦者の没入感や興奮の動態にどのように影響するかを体系的に探求し，分析的なギャップを埋めるに至った．従来の研究では，ゲームの長さや得点頻度などのゲーム特性が観戦者の没入感に広く影響を与える点について貴重な洞察を得られたが，高得点スポーツと低得点スポーツの微妙な相違，スポーツ形式ごとの独自の構造的特性，勝敗に関する不確定性の解決ダイナミクス，試合中の異なるフェーズ，対戦チームや選手間の競争的相互作用など，限定的な知見しか得られていなかった．

対戦チームや選手間の競争的相互作用を明示的に定量化するために，心の重力モデルに基づく新たな分析フレームワークを提案し，実証的に検証を試みた．このフレームワークは，強度，バランス，戦略的ポジションを捉えることを目的とする．これらの試みを通して，理論的枠組みをさらに発展させ，スポーツ競技の観戦者の心理に関する洞察を深め，ゲーム構造と競争のバランスを最適化するための実践的な推奨事項を提供する．

以上，本論文は，ゲーム洗練度理論と心の重力モデルをスポーツ競技の遊戯性と相互作用の評価に対して応用・検証したものであり，学術的に貢献するところが大きい．よって博士（情報科学）の学位論文として十分価値あるものと認めた．