Title	速度のダイナミクス:ゲームが没入的で刺激的になるのはいつか?―ゲーム洗練理論の視点から
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Citation	
Issue Date	2025-09
Type	Thesis or Dissertation
Text version	ETD
URL	http://hdl.handle.net/10119/20076
Rights	
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Abstract

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.