



Acoustic analysis of vocal intensity and decision-making processes in national level soft tennis officiating: a mixed methods study

Análisis acústico de la intensidad vocal y los procesos de toma de decisiones en el arbitraje de Soft Tennis de nivel nacional: un estudio de métodos mixtos

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Abstract

Introduction: The International Soft Tennis Federation mandates a "loud and clear" call for officiating; however, this requirement remains qualitatively abstract without empirical acoustic metrics.

Objective: This study aimed to quantify the vocal intensity of the "out" call among national-level referees and elucidate the cognitive rationale underlying their vocal modulations.

Methodology: An explanatory sequential mixed-methods design (QUAN → qual) was employed. Fifteen national-level referees ($n = 15$) participated in a controlled field simulation on a regulation Soft Tennis court to maintain ecological validity. Vocal intensity (dBA) was measured using a Class 2 sound level meter under three conditions: Appropriate (Baseline), Low, and High intensity. Subsequently, stimulated recall interviews were conducted with a subsample ($n = 6$) to explore decision-making processes.

Results: Quantitative analysis revealed a significant hierarchy in vocal output, $F(2, 28) = 53.891, p < .001, (\eta_p^2 = .794)$. High-intensity calls yielded the highest mean (103.83 ± 5.54 dB), while low-intensity calls (93.69 ± 3.39 dB) were significantly lower than the baseline (98.33 ± 4.23 dB).

Discussion: The findings suggest that vocal intensity is not a static physical requirement but a dynamic strategic instrument. High intensity serves as a "psychological wall" for conflict management during close calls, whereas low intensity reflects "social etiquette" and empathy during obvious errors.

Conclusions: Referees modulate their voice based on situational demands. These findings transition officiating standards from abstract mandates to measurable acoustic benchmarks, advocating for the integration of vocal competency into referee certification programs.

Keywords

Game management; mixed methods; soft tennis; sports officiating; vocal intensity.

Resumen

Introducción: La Federación Internacional de Soft Tennis exige un canto "fuerte y claro" para el arbitraje; sin embargo, este requisito sigue siendo cualitativamente abstracto sin métricas acústicas empíricas.

Objetivo: Este estudio tuvo como objetivo cuantificar la intensidad vocal del canto de "out" entre árbitros de nivel nacional y dilucidar la lógica cognitiva que subyace a sus modulaciones vocales.

Metodología: Se empleó un diseño de métodos mixtos secuencial explicativo (CUAN → cual). Quince árbitros de nivel nacional ($n = 15$) participaron en una simulación de campo controlada en una cancha reglamentaria de Soft Tennis. La intensidad vocal (dBA) se midió utilizando un sonómetro de Clase 2 en tres condiciones: intensidad Adecuada (Base), Baja y Alta. Posteriormente, se realizaron entrevistas de recuerdo estimulado con una submuestra ($n = 6$) para explorar los procesos de toma de decisiones.

Resultados: El análisis cuantitativo reveló una jerarquía significativa en la producción vocal, $F(2, 28) = 53.891, p < .001, (\eta_p^2 = .794)$. Los cantos de alta intensidad alcanzaron la media más alta (103.83 ± 5.54 dB), mientras que los de baja intensidad (93.69 ± 3.39 dB) fueron significativamente menores que la línea base (98.33 ± 4.23 dB).

Discusión: Los hallazgos sugieren que la intensidad vocal no es un requisito físico estático, sino un instrumento estratégico dinámico. La alta intensidad sirve como un "muro psicológico" para la gestión de conflictos, mientras que la baja intensidad refleja "etiqueta social" y empatía durante errores obvios.

Conclusiones: Los árbitros modulan su voz basándose en las demandas situacionales. Estos hallazgos transforman los estándares de arbitraje de mandatos abstractos en referencias acústicas medibles, abogando por la integración de la competencia vocal en los programas de certificación de árbitros.

Palabras clave

Arbitraje deportivo; gestión de juego; intensidad vocal; métodos mixtos; soft tennis.



Introduction

Sports officiating serves as the cornerstone of organized competition, functioning not merely to enforce rules but to preserve fairness, interactional justice (Bosselut et al., 2018), and the overall integrity of the game. Recently, experts suggested that the future of officiating research must look beyond basic rule application to understand the complex human interactions within the sporting environment (Webb & Tingle, 2025). Consequently, the role of the official has evolved from a passive observer to an active manager, requiring sophisticated skills to handle "Game Management" and emotional labor under immense psychological pressure (Zanin et al., 2024). Research indicates that officials must constantly negotiate their authority through both verbal and non-verbal cues to maintain control (Furley & Schweizer, 2016; Tseng & Chen, 2022). The stakes are high; systematic reviews indicated that decision-making training is critical (Plessner et al., 2009), as even minor errors can drastically alter match outcomes and affect the credibility of the sport (Kittel et al., 2025; Wang et al., 2024).

While technology and Artificial Intelligence (AI) are beginning to reshape sports training and assessment—offering automated feedback and biomechanical monitoring (Manescu, 2025)—the nuance of human communication in officiating remains a vital frontier. Unlike standardized digital audio sources, the oral performance in sports officiating provides an essential "acoustic presence" and authoritative timbre that athletes rely on (Nurfadhila et al., 2026). As AI systems for motion assessment become more prevalent (Al Ardha et al., 2025), there is a parallel need to quantify the human elements of game management to provide a comprehensive baseline for future technological integration.

In the specific context of racket sports, recent comparative analyses highlighted that professional sports demand unique physiological and psychological profiles (Subagio et al., 2026). Similarly, referee communication is inherently "multimodal," relying on a synchronized combination of hand signals, body language, and, crucially, the human voice (Laplace & Butler, 2025). For Soft Tennis, the vocal component is paramount due to the sport's unique physical characteristics. Originating in Japan, Soft Tennis utilizes specialized equipment, notably a soft, inflatable rubber ball that is lighter and more flexible than a standard felt-covered tennis ball. These properties directly influence match dynamics—including high-speed baseline rallies—and create a distinct acoustic environment where the referee's voice must compete with the specific sound profile of rubber ball impacts. The Technical Rules of the International Soft Tennis Federation (ISTF, 2025) explicitly mandate that umpires must articulate scores and judgments with a "loud and clear call." This requirement is dictated by the court dimensions and the necessity to convey signals audibly to players positioned at the baseline, as well as to spectators. However, despite this regulatory emphasis, the definition remains abstract. Recent evidence suggests that verbal strategies are not merely technical commands but are intertwined with personality traits and motivational climates (Hidayatullah et al., 2026).

Vocal characteristics—specifically vocal intensity (dB)—are increasingly recognized as key indicators of decisiveness and authority. Within the context of officiating, this implies that a referee's vocal modulation serves as a strategic tool for maintaining sportsmanship and ethical perceptions on the court (Lagoudaki et al., 2026; Yulinar et al., 2026). Currently, no study has quantified the standard decibel levels for the "out" call in Soft Tennis. To address this gap, this study employed an Explanatory Sequential Mixed Methods Design to analyze the acoustic properties of the out call among national-level referees.

Method

Design

This study employed an Explanatory Sequential Mixed Methods Design (QUAN → qual). The research process unfolded in two distinct phases: an initial quantitative phase (Phase 1) to measure vocal intensity, followed immediately by a qualitative phase (Phase 2) utilizing in-depth interviews. This design was selected to allow the qualitative data to elaborate on the mechanisms and cognitive rationale driving the statistical results observed in Phase 1 (Batista & Šimenko, 2026).



Participants

The target population consisted of Soft Tennis referees certified by the Soft Tennis Association of Thailand for the year 2025. Using purposive sampling, 15 national-level referees ($n=15$) were selected. Participants were recruited during an international championship, ensuring they were in peak professional condition and possessed the necessary vocal and auditory integrity (Kurniawan et al., 2025). Inclusion criteria required participants to: (1) hold a valid referee license; (2) possess a minimum of three years officiating experience; and (3) provide informed consent. The sample size was validated via a priori power analysis using G*Power version 3.1.9.7 (Faul et al., 2007) with the following parameters: $\alpha = .05$, $\text{power} = .80$, and $f = 0.40$.

Instruments

Vocal Intensity Measurement (Quantitative): Vocal intensity was measured using a Center 390 Sound Level Meter (IEC 61672-1 Class 2). Following established acoustic protocols in sports assessment (Nurfadhila et al., 2026), the device utilized A-weighting frequency (dBA) and was set to "Fast Response" mode to capture peak decibel levels (Peak dB). This instrument was chosen to capture authentic human vocal performance, prioritizing ecological validity over digital sound stabilization that lacks the authoritative timbre of a human official.

Stimulated Recall Interview Guide (Qualitative): A semi-structured interview guide was developed to explore decision-making processes and situation awareness. Questions were adapted from the framework by Neville and Salmon (2016), focusing on cognitive rationale, perceived pressure, and communicative intent.

Validity and Reliability: All instruments underwent content validity verification by five experts. Item-Objective Congruence (IOC) was calculated, retaining items with $\text{IOC} \geq 0.50$. A pilot test was conducted with three independent referees to ensure protocol clarity.

Procedure

Data collection followed a structured three-step protocol.

Step 1 (Preparation) involved contacting the target group, providing a comprehensive briefing on the research objectives and procedures, and acquiring written informed consent from all participants prior to the commencement of the study.

Step 2 (Phase 1 - Quantitative) was conducted on a regulation Soft Tennis court to simulate the actual officiating environment and maintain ecological validity, with ambient noise levels monitored and maintained below 60 dB. Participants were positioned on the official umpire high chair to replicate the actual body posture and vocal projection angle used during competition. A sound level meter was fixed at a standardized and constant distance of 20 cm from the participant's mouth. Each participant was instructed to vocalize the standard "Out" call three times in the following fixed sequence: (1) Appropriate Intensity (Baseline), defined as the standard volume the referee considers most suitable for normal match communication; (2) Low Intensity, defined as a volume lower than their habitual appropriate level; and (3) High Intensity, defined as a volume higher or louder than their appropriate level. The peak decibel (Peak dB) for each vocalization was recorded.

Step 3 (Phase 2 - Qualitative) involved in-depth interviews using the Stimulated Recall technique (Lincoln & Guba, 1985), conducted immediately following the acoustic measurements in a quiet and private location. This timing ensured that participants could accurately reflect on their thoughts and decision-making processes while the experience remained fresh. The researcher utilized semi-structured interview questions focusing on the "rationale" behind the choice of each vocal intensity level (e.g., "Why do you consider the first level to be appropriate?" and "In what specific situations would you choose to use a higher intensity?"). All interview sessions were audio-recorded for subsequent transcription and supplemented by field notes.

Data analysis

Quantitative Analysis: Statistical analysis was performed using IBM SPSS Statistics (Version 26.0). Descriptive statistics (M and SD) summarized vocal intensity levels. A One-way Repeated Measures ANOVA compared mean decibel levels across the three conditions. Sphericity assumptions were assessed using



Mauchly's test, with Greenhouse-Geisser corrections applied where necessary. Effect sizes were reported using partial eta squared (η_p^2). Post-hoc pairwise comparisons utilized the Bonferroni correction, with statistical significance set at $p < .05$.

Qualitative Analysis: Transcripts were analyzed using Thematic Analysis following the six-step guide by Braun and Clarke (2021). The process involved: (1) familiarization; (2) coding; (3) generating themes; (4) reviewing themes; (5) defining themes; and (6) reporting. To ensure trustworthiness, member checking was performed, allowing participants to verify the accuracy of their transcribed responses.

Integration: Findings were integrated using a Joint Display technique. This involved juxtaposing quantitative results (vocal intensity) with qualitative themes to generate meta-inferences explaining the relationship between physical vocal properties and psychological intent (Batista & Šimenko, 2026).

Ethical considerations

The study was conducted in strict adherence to the Declaration of Helsinki. The research protocol received formal approval from the Human Research Ethics Committee of Sirindhorn College of Public Health, Yala (Certificate No. SCPHYLIRB-2568/847). Prior to data collection, all participants provided written informed consent. To ensure strict anonymity as required by the journal's standards, all acoustic data and interview transcripts were de-identified using alphanumeric codes (R1–R15), and access to raw data was restricted solely to the research team.

Results

Quantitative findings: Vocal intensity analysis

The quantitative phase of this study investigated the differences in vocal intensity (measured in decibels, dBA) across three distinct officiating conditions: Low Intensity, Appropriate Intensity (Baseline), and High Intensity. Data collection involved 15 national-level Soft Tennis referees ($n=15$) utilizing a Center 390 Sound Level Meter.

Descriptive statistics

The descriptive analysis of the vocal intensity levels for the three conditions is presented in Table 1. The results indicated a distinct hierarchy in vocal output based on the specific condition. The High Intensity condition yielded the highest mean vocal intensity (103.83 ± 5.54), followed by the Appropriate Intensity condition (98.33 ± 4.23). The Low Intensity condition demonstrated the lowest mean value (93.69 ± 3.39).

Assumption testing

Prior to conducting the inferential statistical analysis, the assumption of sphericity is assessed using Mauchly's Test of Sphericity. The results indicate that the assumption of sphericity is met ($\chi^2 (2) = 5.819, p = .054$). Therefore, no correction (e.g., Greenhouse-Geisser) was applied, and the degrees of freedom were interpreted directly.

Table 1. Means and Standard Deviations of Vocal Intensity (dB) Across Three Conditions ($n=15$).

Condition	M	SD
Low Intensity	93.69	3.39
Appropriate	98.33	4.23
High Intensity	103.83	5.54

Analysis of variance (ANOVA)

To test the hypothesis that vocal intensity levels differ across the three conditions, a One-Way Repeated Measures ANOVA was conducted (Table 2). The analysis revealed a statistically significant difference in vocal intensity between the conditions, $F (2, 28) = 53.891, p < .001$. Furthermore, the effect size is calculated using Partial Eta Squared. The result showed a large effect size ($\eta_p^2 = .794$), indicating that 79.4% of the variance in vocal intensity is explained by the manipulation of the officiating condition.



Pairwise comparisons

Given the significant main effect found in the ANOVA, post hoc comparisons were performed using the Bonferroni correction to control for Type I error. The analysis revealed significant differences between all pairs of conditions ($p < .001$ for all comparisons):

1. Low vs. Appropriate: The Appropriate Intensity is significantly louder than the Low Intensity condition, with a mean difference of 4.64 dB ($p < .001$).
2. Low vs. High: The High Intensity condition is significantly louder than the Low Intensity condition, with a mean difference of 10.14 dB ($p < .001$).
3. Appropriate vs. High: The High Intensity condition is significantly louder than the Appropriate Intensity condition, with a mean difference of 5.50 dB ($p < .001$).

These findings confirm that referees are capable of distinct and significant vocal modulations, adjusting their projection levels according to the specific demands of the simulated officiating scenarios.

Table 2. Summary of One-Way Repeated Measures ANOVA for Vocal Intensity.

Source	SS	df	MS	F	p	η_p^2
Condition	773.00	2	386.50	53.891	.000*	.794
Error	200.81	28	7.17			

* Note: Significant at the .05 level.

Qualitative findings: The decision-making process

Following the quantitative measurements, in-depth stimulated recall interviews with a subsample of six national-level referees (coded R1–R6) revealed three overarching themes. These themes elucidate the cognitive rationale and perceptual reasons underlying the referees' choice of vocal intensity: (1) Management of Conflict and Uncertainty, (2) Ethics and Social Etiquette, and (3) Experience-Based Intuition.

Theme 1: Management of conflict and uncertainty (Rationale for high intensity)

The primary driver for utilizing High Vocal Intensity was not physical distance, but rather the need to manage game situations characterized by ambiguity or high pressure. Referees described their voice as a "psychological tool" used to project decisiveness and preclude player dissent, particularly during "close calls" (e.g., balls landing near the line). Participants emphasized that a loud, firm call serves as a definitive statement of authority, creating a psychological barrier against potential protests.

"If the ball grazes the line... my first priority is to be decisive. I will raise my voice to show 'OK, I have decided,' effectively reducing the chance of the player starting a protest." (Participant R1) "We use a loud voice only when the call is borderline... It must be loud and firm so that they [the players] believe in and obey our judgment." (Participant R2)

Furthermore, in high-pressure environments with external noise (e.g., cheering crowds), high intensity is used to "penetrate" the noise floor to ensure clarity, protecting the referee from claims of ambiguity.

"Because it was a close call, we must be clear. Increasing the volume emphasizes to the athlete whether it was 'In' or 'Out' beyond any doubt." (Participant R3)

Theme 2: Ethics and social etiquette (Rationale for low intensity)

In contrast, the use of Low Vocal Intensity was associated with "Emotional Intelligence" and social awareness. When a fault is obvious (e.g., a ball clearly landing far out), referees consciously lower their volume to demonstrate respect and empathy for the player who lost the point. Participants viewed unnecessary loudness in these situations as "disrespectful" or as an act of "rubbing in" the mistake.

"If the ball is clearly out... shouting would be disrespectful. We lower the voice to honor the athlete, not to emphasize that they missed by a large margin." (Participant R4)

Additionally, for obvious plays, the low voice serves a functional purpose of energy conservation, acting as a formal confirmation rather than a command.



"The players already know it is out. We just make a sound to formally signal that 'Okay, the call has been made,' saving our energy." (Participant R1)

Theme 3: Experience-based intuition (The mechanism of control)

When asked about the cognitive process preceding the vocalization, referees revealed that the adjustment of decibel levels is not a step-by-step logical calculation. Instead, it is an "Intuitive Response" honed through years of experience. The "Situation Awareness" triggers an automatic physiological response without the need for conscious deliberation.

"There is not enough time to sit and process 'which weight should I use for this shot?'... It comes out naturally by instinct." (Participant R2)

"It is experience... Experience tells us immediately what kind of call the situation demands... Bang! It just happens." (Participant R6)

Mixed methods integration

To provide a comprehensive understanding of the phenomenon, a Joint Display analysis integrates the quantitative statistical results with the qualitative themes. This integration (Table 3) illustrates how the physical properties of the voice (Decibels) are intrinsically linked to the referee's psychological intent.

Synthesis of integrated findings:

1. High Intensity Integration: The statistical peak in decibels (103.83 dB) directly corresponds to the qualitative need for authority. The volume is not physically required for audibility but is psychologically required for stability.
2. Low Intensity Integration: The significant drop in decibels (93.69 dB) confirms that referees prioritize social sensitivity over the "loud and clear" rule when the outcome is unambiguous.
3. Mechanism of Intuition: The statistical consistency (low standard deviation) across participants supports the qualitative finding that this behavior is a shared, automatic professional standard derived from extensive experience, rather than random individual preference.

Table 3. Joint Display of Vocal Intensity Levels and Associated Decision-Making Rationales.

Game Situation	Quantitative Result (QUAN)	Qualitative Rationale (qual)	Meta-Inference
High Pressure / Close Call	Highest Intensity (103.83 dB) Significantly higher than other conditions ($p < .05$)	Theme 1: Management of Conflict "Must be decisive... to reduce protests." (R1) "To build confidence for both the athletes and ourselves." (R4)	Voice as Authority: Referees amplify volume to construct a "psychological wall" that asserts control and suppresses dissent during uncertainty.
Obvious Error / Routine Play	Lowest Intensity (93.69 dB) Significantly lower than baseline ($p < .05$)	Theme 2: Ethics & Etiquette "A soft call shows respect... avoiding emphasis on the error." (R4) "The ball is clear... so we save our voice." (R2)	Voice as Etiquette: Referees modulate volume downwards to maintain social rapport and demonstrate empathy, adhering to implicit social contracts on the court.
Execution Mechanism	Low Variance (Low Standard Deviation)	Theme 3: Intuition "No time to process... comes out naturally." (R2) "Bang! It requires experience." (R6)	Automaticity: Vocal modulation is an internalized skill (embodied cognition), triggered automatically by situational cues rather than conscious calculation.

Discussion

The findings of this study suggest that vocal intensity in Soft Tennis officiating is not merely a functional tool for audibility, but a sophisticated psychological and strategic instrument. By quantifying the "loud and clear" mandate into measurable acoustic data (ranging from 93.69 to 103.83 dB), this research transitions the ISTF regulatory framework from abstract qualitative requirements to an objective scientific baseline.

The acoustic construction of authority and game management



The significant peak in vocal intensity observed during high-pressure scenarios ($M=103.83$ dB) aligns with the concept of "Vocal Authority." From a voice science perspective, the modulation of subglottal pressure and vocal fold tension during "close calls" may reflect an embodied cognitive response to perceived environmental stress. However, beyond a mere physiological reaction, this acoustic surge serves as a deliberate strategic instrument.

As suggested by Cunningham et al. (2025), referees use their voice to manage the "emotional climate" of the match. The strategic use of loudness acts as a signal of confidence, corroborating Wang et al. (2024), who established that visible and audible confidence is a critical predictor of player acceptance. Furthermore, this behavior aligns with Darwin's leakage hypothesis (Furley & Schweizer, 2016); by projecting a firm, high-decibel call, referees mask internal doubt and present an external image of certainty. This performance constitutes a critical component of the referee's "Face-work" on the front-stage (Cunningham et al., 2018), where maintaining an authoritative persona is essential for upholding match order.

In the specific context of Soft Tennis, where the inflatable rubber ball produces unpredictable bounces near the lines, the referee's voice acts as a definitive acoustic boundary. This high-decibel output functions as a "psychological wall," projecting a level of decisiveness that preemptively suppresses player dissent (Samuel et al., 2025). This aligns with the conceptualization of officiating as "Aggression Work" (Zanin et al., 2024) and context-dependent management (Schrödter & Klatt, 2024), where referees proactively use intensity to de-escalate potential conflict. Unlike digital officiating systems that provide neutral feedback, the human voice carries an authoritative timbre essential for maintaining perceived fairness in high-stakes formats (Nurfadhila et al., 2026).

The social and ethical dimensions of "quiet" officiating

In contrast to the high-intensity demands of close calls, the deliberate reduction of vocal intensity during obvious errors ($M=93.69$ dB) highlights the officials' Emotional Intelligence and social awareness. This downward modulation suggests that referees prioritize rapport-building and empathy over the rigid application of the "loud and clear" rule. Shouting at a clear error could be perceived as "rubbing it in" or public shaming; thus, referees engage in "Face-maintaining acts" (Tseng & Chen, 2022), where effective communication necessitates protecting the player's dignity.

By softening the call, officials demonstrate Interactional Justice—treating athletes with respect even while penalizing them (Bosselut et al., 2018) and exhibiting sophisticated Emotional Regulation (Karaçam et al., 2023). Physiologically, this lower intensity reduces the "aggressive" acoustic profile of the call, mitigating the risk of appearing hostile. This finding supports Hidayatullah et al. (2026), suggesting that elite officiating is a pedagogical performance where the official manages the athlete's motivation. This mirrors pedagogical strategies linked to the cultivation of sportsmanship (Yulinar et al., 2026) and is crucial for preserving the ethical climate in regional competitive contexts like the Southeast Asian Games (Lagoudaki et al., 2026). Ultimately, this approach contributes to a less hostile environment and prevents negative interactions that can lead to mental strain (McKeen & Stevinson, 2025).

Intuition and naturalistic decision making

The low variance in vocal output observed among national-level referees supports the existence of "Experience-Based Intuition." This automaticity suggests that vocal modulation has become an "embodied marker" of professional expertise. Rather than a conscious calculation of decibel levels, the referee's physiological mechanism triggers an acoustic response calibrated by years of situational exposure. This aligns with the Naturalistic Decision Making (NDM) framework (Cunningham et al., 2025), where expert officials rely on pattern recognition or Multiple-cue Learning (Plessner et al., 2009) to synthesize complex inputs into an immediate vocal response without deliberative thought.

This process demonstrates high Situation Awareness (Neville & Salmon, 2016). Collectively, these findings indicate that while the "loud and clear" mandate is abstract, expert referees have effectively operationalized it into a consistent, though previously unmeasured, acoustic standard (Quinaud et al., 2026). While prior research has predominantly focused on decision errors (Samuel et al., 2025) or physiological load (McEwan et al., 2024), this study establishes that "Voice" is an integral, internalized component of the referee's toolkit.

Limitations and future directions



Despite the rigorous recruitment of active international-level referees, this study has limitations. First, while their professional status served as a practical screening for vocal health (Kurniawan et al., 2025), formal clinical assessments of vocal fold structure were not conducted. Future research should incorporate laryngeal imaging to explore the physiological limits of officiating calls. Second, while personality traits influence vocal behavior (Hidayatullah et al., 2026), this study did not include extroversion/introversion profiling. Finally, given that data were collected in a controlled simulation, future studies should evaluate the "Perception of Sound" from the athlete's position during live competitive matches to validate the ecological effectiveness of these measured decibel levels in diverse stadium environments (Subagio et al., 2026).

Conclusions

This study challenges the conventional understanding of the "loud and clear" mandate in sports officiating by suggesting that vocal intensity is not a static physical requirement, but a dynamic psychological strategy utilized for effective game management. Through the integration of acoustic measurements and stimulated recall interviews, the results indicate that national-level Soft Tennis referees significantly modulate their vocal magnitude ($p < .05$) in response to the specific psychological demands of the simulated officiating scenarios, rather than merely adjusting for physical distance. Three fundamental conclusions emerge from this investigation:

Voice as an instrument of authority

In high-stakes situations characterized by uncertainty or potential conflict (e.g., close calls), referees instinctively amplify their vocal intensity to a peak average of 103.83 dB. This acoustic surge functions as a "psychological wall," projecting decisiveness to suppress player dissent and assert control over the competitive environment.

Voice as a social bridge

Contrary to the assumption that loudness always equates to officiating quality, this study highlights the phenomenon of "voice as etiquette." Referees deliberately reduce their vocal intensity to 93.69 dB during obvious errors. This modulation serves a critical social function, demonstrating empathy and preserving the athlete's dignity, thereby maintaining the social harmony of the match.

The automaticity of expertise

These complex vocal adjustments are not the product of conscious, step-by-step deliberation. Instead, they represent embodied skills derived from extensive experience. The statistical consistency observed across participants indicates that the ability to intuitively modulate voice is a hallmark of expert situation awareness in sports officiating.

In conclusion, this research suggests that a referee's voice is a sophisticated, multimodal tool that amplifies to command respect and softens to show respect. By providing the first quantified baseline of vocal intensity in Soft Tennis, these findings support the transition of officiating training from abstract qualitative instructions to measurable acoustic standards. These findings advocate for a paradigm shift in referee certification programs, emphasizing the necessity of evidence-based curriculum development that integrates vocal magnitude as a core professional competency. Similar to the systematic evaluation of development needs in specialized sports disciplines, the inclusion of quantified acoustic standards in training protocols is essential to align officiating practices with the contemporary demands of high-performance racket sports. This shift advocates for a context-sensitive approach that recognizes and trains the tactical value of communication in professional racket sports.

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