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Enhancing Meta-Cognitive Regulation in Cricket: A Randomized Controlled Trial of Mindfulness Acceptance Commitment and Psychological Skills Training

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Abstract
This study compared the effects of Mindfulness–Acceptance–Commitment (MAC) and Psychological Skills Training (PST) on meta-cognition in sub-elite cricket players. Forty-five athletes were randomly assigned to MAC, PST, or control groups and assessed across three time points. Linear Mixed Model analysis revealed significant group, time, and interaction effects. Both interventions improved meta-cognition relative to control; however, MAC produced significantly greater and more sustained reductions in dysfunctional meta-cognitive processes than PST. Findings highlight the superiority of acceptance-based approaches in enhancing cognitive regulation and attentional control under pressure.

Keywords: mindfulness, meta-cognition, cricket, MAC, PST

1. Introduction

In contemporary sport, the determinants of performance extend far beyond physical and technical preparation, with psychological processes playing an increasingly central role in shaping athletic outcomes. Athletes are required to operate in complex, high-pressure environments characterized by uncertainty, rapid decision-making, and continuous evaluation. Within such contexts, cognitive and emotional regulation becomes critical, particularly the ability to monitor, interpret, and adapt one's own thought processes—commonly conceptualized as meta-cognition. Meta-cognition enables athletes to maintain attentional focus, regulate internal experiences, and make adaptive decisions under pressure, all of which are essential for optimal performance (Brick et al., 2020; MacIntyre et al., 2023). In sport contexts, meta-cognitive abilities enable athletes to recognize maladaptive thought patterns, adjust attentional focus, and make adaptive decisions under pressure (Brick et al., 2016). For instance, a cricketer experiencing intrusive thoughts about failure can, through meta-cognitive awareness, disengage from these thoughts and redirect attention to task-relevant cues.

Meta-cognition, defined as the awareness and regulation of one's own cognitive processes, plays a central role in self-regulated performance (Flavell, 1979). In applied sport contexts, meta-cognitive skills enable athletes to monitor their thoughts, evaluate performance strategies, and make real-time adjustments under

pressure. For example, the ability to recognize intrusive thoughts and redirect attention toward task-relevant cues can determine whether an athlete maintains performance consistency or experiences breakdown under pressure. Recent sport psychology research has emphasized that such regulatory processes are not merely supportive but foundational to elite performance, particularly in cognitively demanding sports (Brick et al., 2016).

Traditionally, psychological interventions in sport have been dominated by Psychological Skills Training (PST), which includes techniques such as goal setting, imagery, self-talk, and relaxation. PST has demonstrated effectiveness in enhancing performance-related outcomes; however, it is largely grounded in a control-based paradigm that assumes optimal performance requires the regulation or elimination of negative internal experiences. While such strategies can be beneficial, they may also introduce unintended consequences. Efforts to suppress or control thoughts and emotions can increase cognitive load and, in some cases, exacerbate the very experiences they aim to reduce, particularly in high-pressure contexts (Wegner, 1994).

PST is fundamentally grounded in a control-based paradigm, where athletes are trained to regulate or modify thoughts, emotions, and physiological states to achieve an optimal performance mindset. While effective in stable conditions, this approach may become counterproductive in high-pressure environments such as cricket, where intrusive thoughts, uncertainty, and emotional fluctuations are inevitable. Attempts to control or suppress these experiences can increase cognitive load and promote hypervigilance toward one's internal state, thereby disrupting attentional focus and automaticity (Gardner & Moore, 2020; Josefsson et al., 2021).

In response to these limitations, third-wave cognitive-behavioural approaches have gained prominence within sport psychology. One such approach is Mindfulness-Acceptance-Commitment (MAC) training, developed by Frank L. Gardner and Zella E. Moore. MAC integrates principles of mindfulness, acceptance, and commitment derived from Acceptance and Commitment Therapy (ACT), emphasizing psychological flexibility rather than control. Instead of attempting to eliminate unwanted thoughts or emotions, MAC encourages athletes to develop a non-judgmental awareness of internal experiences while maintaining commitment to task-relevant actions (Gardner & Moore, 2007; Zhang et al., 2022).

MAC operates within a contextual and acceptance-based framework, emphasizing psychological flexibility rather than control. Instead of attempting to change internal experiences, athletes are trained to observe thoughts non-judgmentally and disengage from their influence, allowing attention to remain anchored in task-relevant cues. This distinction is particularly important in cricket, where performance depends on rapid perception–action coupling and sustained concentration. Under pressure, a PST-trained athlete may become preoccupied with "correcting" thoughts (e.g., using self-talk or arousal regulation), whereas a MAC-trained athlete is more likely to acknowledge these thoughts without interference and continue executing skills effectively (Noetel et al., 2022; Li et al., 2023).

A key mechanism underlying MAC is its influence on meta-cognitive processes. By fostering awareness and acceptance of thoughts, MAC enhances athletes' ability to observe cognitive activity without becoming entangled in it. This shift from cognitive control to cognitive awareness reduces the impact of maladaptive thought patterns, such as rumination and self-doubt, thereby improving attentional stability and decision-making (Josefsson et al., 2021; Li et al., 2023). In contrast, PST may inadvertently reinforce a performance-monitoring mindset, where athletes become overly focused on regulating their internal states, potentially disrupting automaticity and flow.

From an applied perspective, MAC is particularly relevant for practitioners working in high-performance

sport settings, as it provides athletes with skills to remain engaged in task-relevant behaviour regardless of internal states. Athletes trained in MAC learn to experience thoughts and emotions without becoming entangled in them, thereby reducing their disruptive impact on performance. This approach aligns closely with practitioner observations in team sport settings, where MAC has been reported to enhance attentional focus, emotional regulation, and performance consistency (Josefsson et al., 2020).

The theoretical foundation of MAC is closely linked to psychological flexibility, which refers to the ability to maintain goal-directed behaviour in the presence of challenging internal experiences. Psychological flexibility is considered a key mechanism underlying effective self-regulation and performance in sport contexts. Recent research integrating MAC with broader motivational frameworks, such as Self-Determination Theory, suggests that acceptance-based approaches can support both performance and well-being by addressing athletes' psychological needs and emotional challenges (Gutman et al., 2025).

A critical mechanism through which MAC may influence performance is its impact on cognitive processes, particularly meta-cognition. Unlike PST, which often emphasizes cognitive restructuring, MAC promotes cognitive defusion, enabling athletes to observe thoughts as transient mental events rather than objective truths. This shift reduces cognitive interference and facilitates more efficient attentional control. Furthermore, MAC encourages an external focus of attention, which has been consistently associated with improved motor performance and reduced self-consciousness.

Empirical evidence supports the effectiveness of MAC in enhancing performance-related psychological outcomes. Randomized controlled trials have demonstrated that MAC interventions lead to improvements in mindfulness, emotional regulation, and perceived performance compared to traditional PST approaches (Josefsson, T et al., 2019). More recent meta-analytic findings indicate that MAC produces moderate effects on mindfulness and small but meaningful improvements in sport performance, highlighting its practical relevance in applied settings (Ptáček, M et al., 2023). Additionally, applied studies have shown that MAC interventions can be effectively implemented across different sports and competitive levels, with athletes reporting improvements in both performance and broader life domains (Yau E.K.B et al., 2021).

Despite this growing evidence base, relatively little research has examined the effects of MAC on meta-cognition within sport contexts. Most studies have focused on outcomes such as anxiety reduction, mindfulness, and performance, leaving a gap in understanding how MAC influences higher-order cognitive regulation. This represents a significant limitation, as meta-cognition is a key mechanism through which athletes monitor and adapt their performance in real time.

These theoretical distinctions become particularly relevant in high-pressure sporting contexts such as cricket, where performance is deeply influenced by cognitive and emotional factors. Cricket is a sport that demands sustained concentration, strategic thinking, and precise motor execution, often under conditions of prolonged uncertainty and intermittent play. The cognitive demands are further amplified by the need to process multiple sources of information simultaneously, including opponent behaviour, match context, and environmental conditions.

In India, cricket occupies a uniquely significant cultural and social position, intensifying these psychological demands. Widely regarded as more than just a sport, cricket in India is closely tied to national identity, public sentiment, and commercial interests. High-profile competitions such as the Indian Premier League have transformed the sport into a global spectacle, attracting massive audiences and media attention. While this has elevated the status of players, it has also created an environment of relentless scrutiny and expectation. Indian cricketers, particularly at sub-elite and emerging levels, often experience

substantial performance pressure stemming from multiple sources, including selection uncertainty, public evaluation, and career instability. Research in the Indian context indicates that cricketers frequently report elevated levels of competitive anxiety, burnout, and psychological distress due to these pressures (Kumar & Singh, 2021; Gupta & McCarthy, 2022).

The present study aims to examine the effects of MAC training on meta-cognition among cricket players using a randomized controlled trial design. By comparing MAC with traditional PST, this study seeks to provide both theoretical and applied insights into the mechanisms through which psychological interventions influence performance

2. Materials and Methods

2.1 Participants

Participants were 45 male cricket players aged between 18-25 years who are represented on following tournaments were selected as participants.

1. Kerala Cricket League
2. Presidents Trophy conducted by Kerala Cricket Association
3. Participated in Muthoot U-19 Cricket

The players who have Previous or current experiences in relaxation and mindfulness techniques, including MBSR, PMR, Autogenic Training and psychological skill training and missing two or more training sessions, irrespective of the study condition were ruled out from the study.

2.2 Sampling

Stratified random sampling technique was applied to choose the subjects. Thirty subjects were distributed to three strata. First strata consist of KCL Players, second strata consist of players who represented Kerala Cricket Team and Third strata includes players who participated in Presidents Cup conducted by KCA and Muthoot U-19 Cricket Tournament were randomly divided into mindfulness-acceptance and commitment intervention (n=10), the Psychological Skill Training (n=10) and active control group (n=10).

2.3 *Intervention*

The psychological training sessions was administered under the supervision of a researcher through the assistance of an experienced clinical psychologist.

MAC Training: - MAC Training has a total of seven-week protocol developed by Gardner and Moore (2007) of once in a week session duration of 90 minutes. It includes 1) Providing psychoeducation to the subjects regarding the theoretical and practical aspects of the intervention and an introduction to the full MAC program structure and content. 2) Introducing to mindfulness and its exercises 3) Introduction of cognitive diffusion and how they can be related in a sport context and its exercises 4) Introducing values-driven behaviour: the connection between goals, values, and behaviours is introduced and reviewed and Introduction of the idea of Value Driven Behavior v/s Emotional Driven Behavior 5 Increasing commitment and their relationship to performance-related values and behaviours. 6) Introducing acceptance: Its primary objective is to develop a deeper understanding of experiential avoidance, along with the potential benefits of experiential acceptance when striving to improve performance, through the introduction to acceptance. 7) Skill consolidation and poise - This module focuses on achieving and maintaining behavioural flexibility by combining mindfulness, acceptance, and commitment.

A one-month follow-up assessment was performed after the seven-week training phase. During this period researcher meet with subjects and gave them one-week activities for 4 weeks.

Psychological Skill Training: - To ensure structural equivalence with MAC Training, a training was prepared for this study based on traditional PST. MAC and PST have similar structures, with seven sessions, one session per week, 90 minutes per session, and a group format in both interventions.

The PST program containing following topics. (1) Basics to sport psychology and Introduction to PST and Significance of PST and Types of PST Programs (2) What is Self-Talk and Types of Self - Talk and How to do Self -Talk and homework related to self-talk (3) introduction to Imagery and its types and how to mental imagery (4) practices on the visualization techniques (5) Introduction to Goal Settings: - the SMART model (George T. Doran- 1981) was used for the athletes. (6) Introduction into arousal control and inverted U Hypothesis theory and techniques to do arousal control (7) Teach them how to use all the PST attributes at one time and discuss any difficulties experienced in previous sessions.

Active Control Group: - they are allowed to do their daily routine without exposing them to any sort of psychological training.

Data were collected before the first session, after the seventh session, and one month after the last session.

2.4 Measures

Metacognition Questionnaire-30 (MCQ-30) - Wells, A., & Cartwright-Hatton, S. (2004).

The Metacognitions Questionnaire-30 (MCQ-30), developed by Wells and Cartwright-Hatton in 2004, is a 30-item self-report measure designed to assess individual differences in metacognitive beliefs, judgments, and monitoring tendencies. It evaluates five distinct factors:

1. Positive Beliefs About Worry: Beliefs that worry is beneficial.
2. Negative Beliefs About Uncontrollability and Danger: Beliefs that certain thoughts are uncontrollable and dangerous.
3. Cognitive Confidence: Confidence in one's cognitive abilities, particularly memory.
4. Need to Control Thoughts: Beliefs about the necessity of controlling one's thoughts.
5. Cognitive Self-Consciousness: Tendency to focus attention on one's own thoughts.

Scoring the MCQ-30:

- Response Scale: Each item is rated on a 4-point Likert scale:
  - 1 = "Do not agree"
  - 2 = "Agree slightly"
  - 3 = "Agree moderately"
  - 4 = "Agree very much"
- Subscale Composition: Each subscale consists of 6 specific items:

1. Positive Beliefs About Worry:
- Items: 1, 7, 10, 19, 23, 28

2. Negative Beliefs About Uncontrollability and Danger:
- Items: 2, 4, 9, 11, 15, 21

3. Cognitive Confidence:
- Items: 8, 14, 17, 24, 26, 29

4. Need to Control Thoughts:
- Items: 6, 13, 20, 22, 25, 27

5. Cognitive Self-Consciousness:
- Items: 3, 5, 12, 16, 18, 30

- Calculating Scores:
  - Subscale Scores: Sum the ratings for the 6 items in each subscale.

- Possible range for each subscale: 6 to 24
- Total Score: Sum the scores of all 30 items.
- Possible range for total score: 30 to 120

Interpretation:

- Higher scores on a subscale indicate stronger endorsement of the specific metacognitive beliefs or tendencies assessed by that subscale.
- Elevated total scores suggest a higher overall level of dysfunctional metacognitive activity, which may be associated with various psychological disorders.

2.5 Statistical Analysis

The data were analysed using a Linear Mixed Model (LMM) within the Mixed Model for Repeated Measures (MMRM) framework to examine the effects of Mindfulness–Acceptance–Commitment (MAC) training and Psychological Skills Training (PST) on psychological flexibility among cricket players. Group (MAC, PST, and Control) and Time (Pre-test, Post-test, and Follow-up) were specified as fixed effects, including their interaction (Group × Time). Participants were treated as a random factor by specifying a random intercept to account for individual variability and the correlation of repeated observations within subjects. An unstructured covariance matrix was selected to model the variance–covariance structure of repeated measures, allowing maximum flexibility in estimating variances and covariances across time points. Model parameters were estimated using Restricted Maximum Likelihood (REML). Model fit was evaluated using Akaike's Information Criterion (AIC) and Bayesian Information Criterion (BIC). Post-hoc pairwise comparisons with Bonferroni adjustment were conducted to examine differences between groups and time points. The level of statistical significance was set at $p < .05$. Statistical procedures were carried out using IBM SPSS (Version 25).

3. Results

The Linear Mixed Model (LMM) analysis revealed substantial changes in meta-cognition over time, as well as significant differences between groups. Model fit indices indicated an adequate fit to the data (AIC = 20.93, BIC = 29.44). The analysis demonstrated significant main effects of group, $F(2, 41.96) = 25.28$, $p < .001$, and time, $F(2, 82.94) = 624.31$, $p < .001$, indicating that meta-cognition scores varied significantly across intervention groups and measurement occasions. A significant Group × Time interaction was also observed, $F(4, 82.94) = 121.67$, $p < .001$, suggesting that the pattern of change in meta-cognition differed across groups over time. Estimated marginal means indicated marked reductions in meta-cognition scores in both intervention groups, with a greater decrease in the MAC group (71.60 to 40.53) compared to the PST group (72.33 to 52.73), while the control group showed only minimal change (70.20 to 64.07).

Bonferroni-adjusted pairwise comparisons revealed that both MAC and PST groups demonstrated significantly lower meta-cognition scores compared to the control group ($p < .001$). Additionally, a significant difference was observed between MAC and PST ($p = .023$), indicating that the MAC intervention was more effective than PST in reducing meta-cognition. Overall, these findings highlight the superior and sustained impact of MAC relative to PST and the control condition.

Table.1 Descripitrive Statistics (Estimated Marginal Means Across Groups and Time)

Training Group	Pre-test Mean	Post-test Mean	Follow-up Mean	Mean Difference (Pre–Follow-up)
PST	75.60	92.73	96.00	20.40
MAC	76.93	100.40	104.33	27.40
Control Group	76.20	81.67	84.40	8.20

Table.1 provides the descriptive analysis of meta-cognition improvements across the three groups. At baseline, all groups demonstrated relatively similar meta-cognition scores, with PST (M = 75.60), MAC (M = 76.93), and the control group (M = 76.20), indicating initial comparability.

Following the intervention, both treatment groups exhibited notable improvements; however, the Mindfulness-Acceptance-Commitment (MAC) group showed a greater increase (M = 100.40) compared to the Psychological Skills Training (PST) group (M = 92.73), while the control group demonstrated only a modest rise (M = 81.67).

At follow-up, these trends were further accentuated. The MAC group achieved the highest scores (M = 104.33), followed by the PST group (M = 96.00), with the control group remaining substantially lower (M = 84.40). The magnitude of change from pre-test to follow-up was largest in the MAC group (ΔM = 27.40), followed by the PST group (ΔM = 20.40), and was minimal in the control group (ΔM = 8.20).

Table.2 Tests of Fixed Effects for Meta Cognition

Effect	F	df	p-value	Effect Size η^2
Group	51.54	(2, 41.64)	< .001	0.71
Time	1721.79	(2, 82.42)	< .001	0.98
Group × Time	191.56	(4, 82.42)	< .001	0.90

Table.2 presents the Bonferroni-adjusted pairwise comparisons examining changes in Meta Cognition across the three time points (pre-test, post-test, and follow-up).

A linear mixed model analysis revealed a statistically significant main effect of Group, F (2, 41.64) = 51.54, $p < .001$, $\eta^2 = .71$, indicating that meta-cognition scores differed significantly among the MAC, PST, and control groups when averaged across time points. The effect size was large, suggesting that group membership accounted for a substantial proportion of the variance in meta-cognition outcomes.

There was also a highly significant main effect of Time, F (2, 82.42) = 1721.79, $p < .001$, $\eta^2 = .98$. This very large effect size indicates that meta-cognition scores changed markedly across the three measurement occasions (pre-test, post-test, and follow-up), regardless of group. Such a strong time effect suggests that the interventions, as well as the passage of time, contributed significantly to changes in meta-cognitive functioning.

Importantly, the Group × Time interaction was statistically significant, F (4, 82.42) = 191.56, $p < .001$, $\eta^2 = .90$, with a very large effect size. This finding indicates that the trajectory of change in meta-cognition over time differed significantly across the three groups.

Table.3 Pairwise Comparison across Group

Comparison	Mean Difference	SE	p-value
PST vs MAC	5.78	1.30	< .001
PST vs Control	7.36	1.30	< .001
MAC vs Control	13.13	1.30	< .001

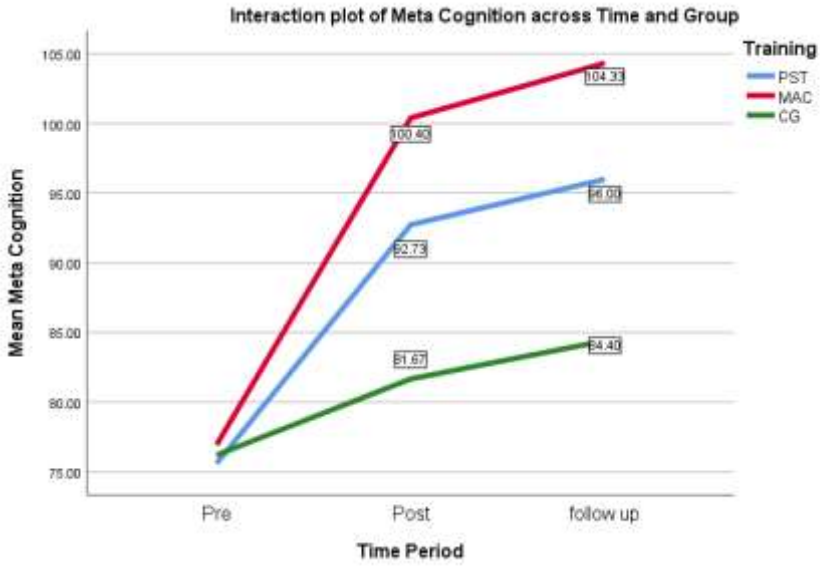
Table.3 presents the Bonferroni-adjusted pairwise comparisons examining differences in Meta Cognition between the MAC, PST, and Control Group

Bonferroni-adjusted pairwise comparisons revealed significant differences in meta-cognition scores between all training groups. Specifically, the comparison between the PST and MAC groups indicated that the MAC group demonstrated significantly higher meta-cognition scores than the PST group (Mean diff = 5.78, SE = 1.30, $p < .001$).

Similarly, the PST group scored significantly higher than the control group (Mean diff = 7.36, SE = 1.30, $p < .001$), indicating that psychological skills training was effective in improving meta-cognition relative to no intervention.

The largest difference was observed between the MAC and control groups, with MAC showing substantially higher meta-cognition scores (Mean diff = 13.13, SE = 1.30, $p < .001$). This finding highlights the strong impact of mindfulness-acceptance-based training compared to no training.

Figure.1 Interaction plot of Meta Cognition across Time and Group



4. Discussion

The present study aimed to examine whether there is a significant difference between Mindfulness Acceptance Commitment (MAC) and Psychological Skills Training (PST) on meta-cognition among cricket players. The Present study showed that MAC is more effective than PST in enhancing meta-cognition because it develops core cognitive processes like awareness, monitoring, and regulation, rather than relying solely on performance techniques. According to Barry Zimmerman's Self-Regulated Learning (SRL) Theory effective performance of an individual depends on their ability to plan, monitor, and evaluate their cognitive processes. MAC strengthens all these phases by promoting continuous awareness of internal states, thereby enhancing real-time cognitive monitoring and reflective evaluation. In contrast, PST relies more on structured techniques such as goal setting, self-talk and imagery, which support

planning but may not consistently develop ongoing cognitive monitoring, which is a key component of meta-cognition. That is MAC training produces dynamic self-regulation strategies whereas PST is more relay on the static regulation strategies where cognitive monitoring was developed effectively.

One key mechanism underlying MAC's superiority is cognitive defusion. In high-pressure cricket situations, athletes often experience intrusive thoughts (e.g., fear of failure). MAC teaches players to detach from these thoughts, reducing their impact. This enhances meta-cognitive awareness—players become observers of their cognition rather than reactors. PST, in contrast, attempts to replace negative thoughts, which may not always be effective under intense stress.

Effective performance requires athletes to stay focused for a long time and also shift their attention when needed. MAC helps by teaching athletes to notice where their attention is at any moment—whether it is on the task or distracted—and gently bring it back to the present. Over time, this builds a strong ability to monitor and control their own focus, which improves meta-cognition. In contrast, PST usually gives specific instructions like "focus on the ball" or "use cue words." While helpful, these are more external strategies, and athletes may depend on them. In difficult or changing situations, they may struggle to adjust their focus on their own. Therefore, MAC is more effective because it develops independent attentional control, leading to better thinking and performance.

MAC helps athletes engage more deeply with their thoughts and experiences. Instead of just applying a technique, they pause, observe, and reflect on how they think and feel during performance. This deeper reflection helps them understand their own thinking patterns, which improves meta-cognition over time. In contrast, PST often focuses on using specific techniques like self-talk or imagery to improve performance. While these can be useful, they usually work at a surface level, meaning athletes apply the technique without deeply understanding their thinking process. Because of this, MAC leads to stronger and more lasting meta-cognitive development than PST.

5. Conclusion

The present study demonstrates that both MAC and PST interventions significantly improve meta cognition among cricket players over time; however, MAC emerges as the more effective approach. The significant Group × Time interaction indicates that improvements in meta cognition are not uniform but depend on the type of intervention, with MAC producing greater and more sustained gains. These findings underscore the importance of incorporating acceptance-based and value-driven psychological frameworks in sports training. Despite minor model limitations, the results provide strong empirical support for the application of MAC interventions to enhance psychological resilience and long-term performance in athletes.

6. Acknowledgement

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7. Data availability statement

Data supporting the findings of this study are cannot publicly available due to the confidential nature of participant information. However, data may be made available from the corresponding author upon reasonable request and with appropriate ethical approval.

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