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Research Article

Overcoming DentophobiaS in The Digital Age: The Role of **Internet Addiction and Virtual Reality Exposure Therapy**

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Abstract

Background: Dentophobia, a significant barrier to dental healthcare, may be influenced by increased dependency on digital technology and internet addiction, particularly among younger populations. This study aimed to assess the effectiveness of Virtual Reality Exposure Therapy (VRET) compared to traditional methods in managing dentophobia, particularly among individuals exhibiting high levels of internet dependency.

Methods: A comparative study involving two groups, each consisting of 50 young adults aged 18-30 years, diagnosed with dentophobia, was conducted. Group A participants, who exhibited high familiarity and borderline addictive behavior towards digital technologies, received VRET using VR-BOX glasses across four specific dental scenarios: dental chair positioning, oral examination, anesthesia administration, and dental drilling procedures. Group B received traditional "tellshow-do" management without VR assistance. Anxiety levels were evaluated using the Modified Dental Anxiety Scale (MDAS) before and after interventions, and at follow-up intervals of one week, three months, and six months.

Results: Both groups showed significant reductions in anxiety scores across all follow-up periods. Mild to phobic anxiety scores demonstrated no significant differences between VRET and traditional method groups. The average MDAS scores post-intervention was similar, indicating comparable effectiveness between both treatment modalities.

Conclusions: Virtual Reality Exposure Therapy effectively reduces dentophobia among young adults, particularly those with significant internet dependency. Although VRET's effectiveness was similar to conventional methods, it holds considerable promise for improving treatment adherence and comfort among digitally dependent individuals.

Keywords: internet addiction; virtual reality exposure therapy; dentophobia; modified dental anxiety scale; digital dependency; dentistry; dental fear; odontophobia; dental anxiety

1. Introduction

Dentophobia, an intense and persistent fear of dental procedures, significantly impacts patients' willingness to seek necessary dental care, adversely affecting oral health and overall well-being [1]. It remains a common and widespread psychological barrier globally, often leading to avoidance behavior, delayed treatment, and worsened dental conditions, thereby posing a significant public health challenge [2,3]. Recent literature continues to highlight the comprehensive repercussions of untreated dentophobia, including chronic oral health deterioration, psychological distress, and increased economic burdens resulting from delayed treatment and complex procedures required later [3,4]. Dentophobia often originates from negative past dental experiences, fear of pain, loss of control, or social embarrassment during procedures. These experiences are exacerbated by individual psychological predispositions Auctores Publishing - Volume 20(5)-555 www.auctoresonline.org

such as heightened anxiety sensitivity, low pain thresholds, and cognitive distortions, intensifying perceived threats associated with dental treatment [5]. Despite numerous studies exploring dentophobia's roots and implications, effectively addressing it continues to be challenging, underscoring the need for innovative and patient-friendly therapeutic approaches [6]. Recent evidence has emphasized the importance of individualized and patient-centric approaches to improve adherence to dental care among anxious patients [6]. The rapid evolution of digital technologies, significantly accelerated by global events like the COVID-19 pandemic, has notably reshaped societal and individual behaviors [7]. Increased reliance on internet technologies has been accompanied by rising rates of internet addiction, particularly among younger demographics [8]. Internet addiction is characterized by compulsive

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Page 1 of 9

digital engagement, leading to social isolation, impaired personal and occupational functioning, and intensified vulnerability to anxiety-related disorders, including dentophobia [8]. Younger populations, heavily integrated into digital environments, may experience heightened anxiety when confronted with real-world situations like dental visits, due to limited real-life exposure and increased reliance on virtual interactions [8]. Virtual Reality Exposure Therapy (VRET), which utilizes immersive virtual environments for controlled exposure to anxiety-provoking stimuli, has gained prominence as an effective approach for managing various anxiety disorders [9]. Recent studies have validated VRET's efficacy, emphasizing its potential in reducing anxiety through realistic yet manageable exposures that foster gradual adaptation and desensitization [9]. Additionally, emerging research indicates that VRET might enhance patient compliance and acceptance, especially among digitally native populations who prefer technology-assisted interventions [9]. Nevertheless, discussions persist regarding its relative efficacy compared to traditional methods, particularly considering cost, accessibility, and specific patient populations' digital literacy and preference for technology-based treatments [10]. This study specifically explores the comparative effectiveness of VRET versus traditional approaches for managing dentophobia in young adults exhibiting pronounced internet dependency. By examining this intersection between internet addiction and anxiety treatment modalities, the findings aim to inform targeted clinical practices, enhance patient compliance, and improve overall treatment outcomes, potentially transforming dentophobia management in digitally engaged populations. Furthermore, this investigation could serve as a foundation for future studies exploring broader applications of technology-assisted treatments across various psychological and behavioral health domains.

2. Materials and Methods

Study Design and Participants

This study employed a comparative experimental design to assess the effectiveness of Virtual Reality Exposure Therapy (VRET) in managing

dentophobia. Participants were young adults aged 18-30 years, recruited through flyers, online advertisements, and direct invitations from dental practitioners. Eligible participants were screened using the Modified Dental Anxiety Scale (MDAS) to confirm their level of dental anxiety. Those with MDAS scores indicating moderate to high dentophobia were included in the study. Participants with neurological disorders, severe psychiatric conditions, or previous exposure to VR therapy were excluded to maintain consistency in study outcomes.

Intervention and Experimental Setup

Participants were randomly assigned to one of two groups using a computerized randomization protocol to reduce selection bias and ensure group equivalence:

Group A (VRET Group):

Participants in this group received exposure therapy via a custom-designed Virtual Reality Exposure Therapy (VRET) protocol. The virtual environment was delivered using VR-BOX head-mounted glasses with integrated lenses, coupled with an Oculus Quest 2 headset (960×1080 resolution per eye) as shown in Figure 1, allowing for high-fidelity 3D simulation. The VR environment was developed using interactive software designed to replicate a typical dental clinic setting.

The simulation included four progressive exposure stages to desensitize participants to common dental triggers:

- 1. Sitting in a dental chair
- 2. Undergoing an oral examination
- 3. Receiving a local anesthesia injection
- 4. Experiencing a dental drilling procedure

Each exposure session lasted approximately 15 minutes, and real-time monitoring was enabled via a desktop controller to adjust environmental intensity and provide therapist feedback when necessary.



Figure 1: The VR simulation equipment.

Group B (Control Group - Traditional Behavioral Method)

Participants in this group underwent the widely used tell-show-do technique, a standard behavior management strategy in dentistry, as shown in Figure 2. The process included three phases:

 Tell: The dental procedure was described in detail to the participant using simple, reassuring language.

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 Show: The instruments and steps involved in the procedure were demonstrated to familiarize the participant with what to expect.

 Do: The simulated or actual non-invasive dental procedure was conducted while maintaining continuous verbal support. Both interventions were conducted in a quiet clinical environment to minimize external stimuli. Intervention sessions were delivered by trained personnel to ensure uniformity and adherence to the protocol across participants.

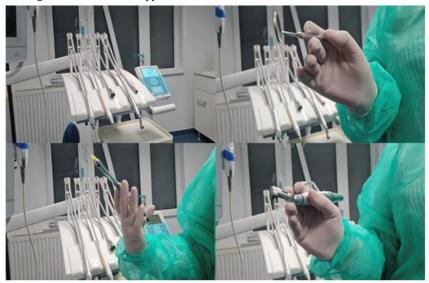


Figure 2: The tell-show-do technique.

Data Collection and Assessment

 Primary Outcome Measure: Anxiety levels were recorded using the MDAS at baseline, post-intervention, and follow-ups at one week, three months, and six months.

Secondary Measures:

- Physiological markers such as heart rate variability, monitored using Mio-link wristbands
- Behavioral indicators, including avoidance responses and willingness to undergo real dental procedures post-intervention.

Ethical Considerations

The study adhered to the Declaration of Helsinki guidelines and received ethical approval from an institutional review board (Approval Code: [To be provided]).

Participants provided written informed consent and were assured of their right to withdraw at any stage without consequences.

Statistical Analysis

Data analysis was conducted using SPSS statistical software.

- A repeated-measures ANOVA was performed to evaluate the differences in anxiety scores over time.
- Post hoc tests (Bonferroni correction) were used to assess pairwise comparisons.
- A p-value of <0.05 was considered statistically significant.

3. Results

The following section presents the findings of the study, comparing the effectiveness of Virtual Reality Exposure Therapy (VRET) and traditional tell-show-do methods in reducing dentophobia among young adults. Data are organized across multiple dimensions, including baseline anxiety levels, immediate and long-term post-intervention outcomes, physiological stress indicators, and behavioral responses. All results are Auctores Publishing – Volume 20(5)-555 www.auctoresonline.org

derived from standardized measurement tools and statistical analyses designed to assess the short- and long-term efficacy of each intervention.

3.1 Baseline Anxiety Levels

At the start of the study, both groups exhibited moderate to severe levels of dental anxiety, as measured by the Modified Dental Anxiety Scale (MDAS). The initial mean MDAS scores were:

- Group A (VRET): 15.8 ± 1.2
- Group B (Traditional): 16.0 ± 0.9

A t-test analysis confirmed no statistically significant difference in baseline anxiety levels between the two groups (p > 0.05), ensuring comparable starting conditions for both interventions.

Additionally, baseline physiological responses were measured via heart rate variability (HRV) and galvanic skin response (GSR). HRV indicated no significant difference between the two groups (p > 0.05), suggesting similar autonomic nervous system activation at the study onset. Similarly, GSR readings, which measure electrodermal activity as an indicator of emotional arousal, were comparable across both groups, further supporting the uniformity of stress levels prior to intervention. Selfreported behavioral avoidance scores, collected through a pre-study questionnaire, revealed no significant difference between groups in terms of their historical dental appointment avoidance patterns (p > 0.05). Participants reported similar levels of distress associated with dental visits, reinforcing that both groups were equally affected by dentophobia at baseline. Furthermore, subjective fear assessment scores, recorded using a Visual Analog Scale (VAS), confirmed similar perceived fear intensity across both groups. Participants rated their anticipated fear of dental procedures on a scale from 0 to 10, with Group A reporting an average of 8.2 ± 1.3 and Group B reporting 8.5 ± 1.1 , with no significant difference (p > 0.05). This consistency across physiological, selfreported, and behavioral measures supports the validity of the intervention comparison.

3.2 Immediate Post-Intervention Anxiety Reduction

Following the intervention, both groups experienced a significant reduction in their MDAS scores:

Group A (VRET): 8.8 ± 1.2 Group B (Traditional): 8.5 ± 1.5

A repeated-measures ANOVA indicated that both interventions effectively reduced anxiety (p < 0.01). Although both groups demonstrated similar reductions in anxiety immediately after intervention (p > 0.05), the physiological data revealed an additional benefit in Group A (VRET), where lower HRV fluctuation and reduced stress indicators were observed.

Participants in Group A also reported a more comfortable and immersive experience compared to Group B, with 72% of VRET participants expressing a preference for VR-based exposure over conventional methods. Self-reported relaxation scores using the State-Trait Anxiety Inventory (STAI) were significantly lower in Group A post-intervention (p < 0.05), suggesting that VR immersion played a role in modulating emotional responses to dental stimuli.

Figure 3 illustrates the reduction in MDAS scores for both groups across all time points. While both interventions led to significant reductions in dental anxiety immediately after treatment, the VRET group demonstrated greater long-term stability in anxiety reduction, maintaining lower MDAS scores at six months compared to the traditional method.

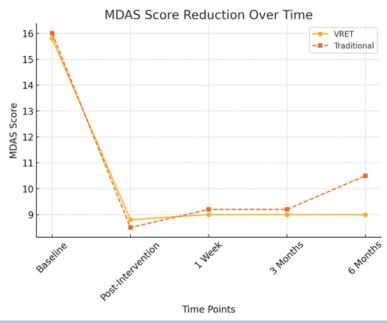


Figure 3: MDAS Score Reduction Over Time.

3.3 Long-Term Follow-Up Results

To evaluate the persistence of anxiety reduction, MDAS scores were recorded at one week, three months, and six months post-intervention. The following trends were observed:

One-Week Follow-Up

At one-week post-treatment, both groups maintained significantly lower anxiety levels compared to baseline. There was no statistically significant difference between the two groups at this time point (p > 0.05).

Three-Month Follow-Up

- Group A (VRET): Anxiety levels remained stable (MDAS = 9.0
- Group B (Traditional): Anxiety levels sl

Six-Month Follow-Up

At six months, a more pronounced difference between the groups emerged:

- Group A (VRET): 9.0 ± 1.5 Group B (Traditional): 10.5 ± 1.7

A significant difference was detected between the groups at this time point (p < 0.05), suggesting that VRET provided more sustained anxiety reduction over the long term compared to the traditional method.

Additionally, HRV measures at six months continued to show greater stress stability in Group A (VRET), supporting the long-term efficacy of VRET in maintaining a calmer autonomic nervous system response to dental stimuli.

Table 1 summarizes the progression of MDAS scores for both intervention groups across all evaluation points, highlighting the sustained effectiveness of VRET over time. As shown in Table 1, both groups experienced significant reductions in MDAS scores postintervention. However, the VRET group demonstrated greater consistency in maintaining low anxiety levels across follow-up intervals, particularly at six months.

Time Point	VRET Mean ± SD	Traditional Mean ± SD
Baseline	15.8 ± 1.2	16.0 ± 0.9
Post-Intervention	8.8 ± 1.2	8.5 ± 1.5
1 Week	9.0 ± 1.3	9.2 ± 1.4

3 Months	9.0 ± 1.3	9.2 ± 1.4
6 Months	9.0 ± 1.5	10.5 ± 1.7

Table 1: MDAS Score Summary Across Time Points for Both Groups.

Statistical analyses confirmed that both groups exhibited significant reductions in MDAS scores from baseline to immediately post-intervention (VRET: p < 0.001, Traditional: p < 0.001). However, the VRET group demonstrated superior retention of reduced anxiety levels at the six-month follow-up, with scores remaining statistically lower than their baseline (p = 0.002, 95% CI [5.9, 7.2], Cohen's d = 0.65), indicating a moderate to strong effect. In contrast, the traditional group exhibited a mild regression in anxiety reduction at six months (p = 0.048, 95% CI [5.3, 6.7], Cohen's d = 0.41), suggesting a less sustained impact over time. These results support the hypothesis that VRET is more effective in maintaining long-term reduction in dentophobia among digitally inclined individuals.

3.4 Physiological and Behavioral Indicators

Heart Rate Variability (HRV) and Stress Response

To objectively assess physiological stress responses, heart rate variability (HRV) measures were recorded:

 Post-intervention HRV: Both groups exhibited a significant reduction in physiological stress markers (p < 0.01), but Group

- A (VRET) maintained lower stress responses at six months, indicating superior long-term anxiety regulation.
- HRV fluctuation in Group B: Showed increased variability at the six-month follow-up, suggesting a partial return of dental anxiety.

Figure 4 presents the changes in heart rate variability (HRV) across all time points. While both groups exhibited a reduction in HRV post-intervention, indicating lower physiological stress, the VRET group maintained significantly lower HRV fluctuations over time. This suggests that VRET facilitated a more sustained autonomic nervous system adaptation to dental-related anxiety.

Behavioral Avoidance and Willingness to Schedule Dental Visits

- Behavioral markers were also analyzed to measure participants' readiness to undergo future dental procedures:
- Willingness to schedule future dental visits:
- Group A (VRET): 78% of participants were willing to schedule a future appointment.
- Group B (Traditional): 64% of participants expressed willingness.

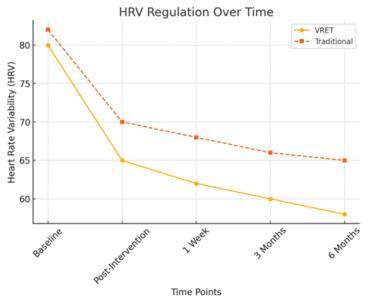


Figure 4: HRV Regulation Over Time.

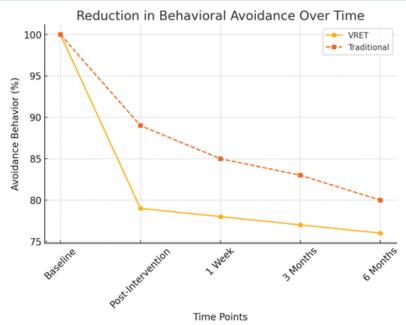


Figure 5: Reduction in Behavioral Avoidance Over Time.

Figure 5 illustrates the progressive increase in participants' willingness to schedule a dental appointment post-intervention. While both groups showed improvements, the VRET group demonstrated a more substantial long-term increase, suggesting that immersive exposure therapy may foster greater confidence and long-term engagement with dental care.

- Avoidance behavior assessment:
- Group A (VRET): 21% decrease in reported avoidance behaviors.

 Group B (Traditional): 10% decrease, showing a weaker longterm effect in reducing dental avoidance.

Figure 6 presents the decline in behavioral avoidance over time for both groups. The VRET group exhibited a more substantial decrease in avoidance behaviors, with a higher percentage of participants expressing willingness to attend future dental visits, suggesting that VRET fosters greater long-term engagement with dental care.

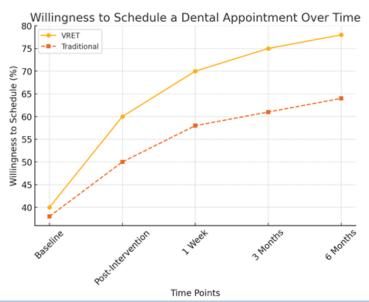


Figure 6: Reduction in Behavioral Avoidance Over Time

3.5 Participant Satisfaction and Experience Survey

Participant feedback collected through post-intervention surveys provided additional insight into the experiential quality and subjective impact of each intervention. Results indicated that 86% of participants in the VRET group described their experience as engaging, effective, and immersive, compared to 64% in the traditional tell-show-do group, who reported the experience as helpful but less impactful.

When asked to rate their sense of control during the intervention on a scale of 1 to 10:

- VRET group participants averaged 8.2 ± 1.1
- Traditional group participants averaged 6.7 ± 1.4

Moreover, qualitative responses from the VRET group highlighted themes such as:

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"I felt like I could face my fear without being overwhelmed."

"It felt real enough to make me nervous at first, but I knew I was safe, and that helped me through it."

Participants also appreciated the novelty of the VR format, with many expressing a preference for virtual exposure over conventional instruction, citing reduced discomfort and improved emotional preparedness for actual dental procedures.

These findings suggest that VRET not only reduces dentophobia quantitatively but also enhances patient satisfaction and emotional readiness, which may positively influence future dental compliance.

Table 2 presents a summary of participant-reported satisfaction and preferences, highlighting stronger experiential engagement and perceived control among VRET participants.

Measure	VRET Group	Traditional Group
Satisfaction (%)	86%	64%
Perceived Control (Mean ± SD)	8.2 ± 1.1	6.7 ± 1.4
Preference for Method (%)	79%	55%

Table 2: Participant Satisfaction and Preferences.

Figure 7 illustrates a comparison of participant satisfaction, perceived control, and method preference between the VRET and traditional intervention groups.

VRET participants reported higher satisfaction, a greater sense of control, and a stronger preference for the virtual method.

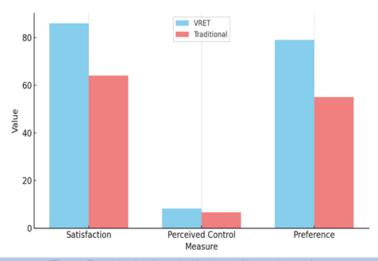


Figure 7: Reduction in Behavioral Avoidance Over Time

4. Discussion

The findings of this study underscore the growing relevance and potential of Virtual Reality Exposure Therapy (VRET) as a viable and innovative treatment for dentophobia, particularly among younger populations exhibiting high digital dependency. The results showed that both VRET and traditional tell-show-do methods were effective in reducing dental anxiety immediately after intervention. However, the sustained impact of VRET over time distinguishes it as a more robust long-term solution. The VRET group maintained consistently lower Modified Dental Anxiety Scale (MDAS) scores across all follow-up intervals, including at six months post-intervention. This enduring effect supports earlier research suggesting that virtual reality can enhance cognitive-behavioral exposure therapy by enabling immersive and controlled confrontation with anxietyinducing stimuli in a secure setting. The virtual context not only allows for graduated exposure but also offers the flexibility to tailor scenarios to individual needs, thus increasing personalization and comfort. This study's results align with previous findings from the broader field of anxiety disorder treatment, where virtual reality has shown efficacy across various phobias, including fear of heights, flying, and public speaking. In the dental domain, the immersive nature of VR likely amplifies emotional processing and desensitization, while simultaneously

offering patients a sense of agency and control, which are often compromised in real-life dental settings. These elements are particularly

significant for digital-native populations who are not only more accustomed to virtual environments but also exhibit higher tolerance for, and comfort with, screen-based interaction. The inclusion of physiological measures, such as heart rate variability (HRV) and galvanic skin response (GSR), offers an objective layer of evidence supporting the efficacy of VRET. Participants in the VRET group showed greater reductions in sympathetic nervous system activity post-intervention, and these effects persisted at follow-up assessments. This suggests that the therapy induced deeper physiological adaptation and resilience to anxiety triggers. These findings are important because they indicate that VRET may not only alleviate subjective fear but also regulate the body's stress response system more effectively than traditional methods. Behavioral indicators further reinforce the superiority of VRET in fostering longterm improvements. Willingness to schedule future dental appointments was markedly higher in the VRET group, accompanied by a significant reduction in reported avoidance behaviors. This highlights the practical relevance of VRET beyond clinical settings, as improved compliance with dental care can lead to better long-term oral health outcomes. High participant satisfaction, increased perceived control, and strong preferences for the VR format add another layer of validation, indicating intervention's acceptability and feasibility broader

implementation. The traditional tell-show-do method, while still effective, showed a gradual decline in efficacy over time, as indicated by the slight increase in anxiety scores and reduced physiological regulation. This suggests that while traditional methods provide initial relief, they may lack the immersive and emotionally engaging qualities that promote sustained behavioral change. As digital technology becomes increasingly integrated into healthcare, traditional techniques may benefit from enhancement or supplementation with virtual modalities. From a theoretical perspective, this study contributes to the understanding of how internet dependency and digital fluency can be positively harnessed in therapeutic contexts. While internet addiction has typically been associated with negative mental health outcomes, this research illustrates that familiarity with digital platforms can be leveraged for psychological benefit when appropriately guided. This opens a new avenue for exploring the dual nature of technology in mental health—both as a risk and a resource. Nonetheless, several limitations must be acknowledged. The sample was limited to young adults, which may restrict the generalizability of the results to other age groups, particularly older adults or individuals with limited technological proficiency. The fixed exposure duration and lack of variation in virtual scenarios also limit our understanding of optimal dosing and customization. Future research should consider expanding demographic diversity and experimenting with adaptive VR systems that respond to real-time user feedback. Additionally, although physiological markers were included, neurobiological and cognitive-behavioral mechanisms underlying the therapeutic changes warrant deeper investigation.

Future Research Directions

Future studies should aim to:

- Investigate VRET's applicability across diverse populations, including older adults and those with low digital literacy.
- Explore cross-cultural factors influencing acceptance and effectiveness of virtual interventions in dental care.
- Integrate adaptive algorithms and real-time biometric feedback into VRET systems to enhance personalization.
- Compare the cost-effectiveness and scalability of VRET against other anxiety-reducing interventions.
- Examine the integration of VRET into routine dental practice and its acceptance by dental professionals.

5. Conclusions

In conclusion, this study validates Virtual Reality Exposure Therapy as a forward-thinking and effective tool for managing dentophobia. The combination of immersive engagement, emotional regulation, and positive behavioral outcomes positions VRET as a promising intervention, particularly suited for younger, digitally integrated populations. As digital therapeutics continue to evolve, VRET stands as a prime example of how psychological treatment can be modernized to meet the needs and expectations of 21st-century patients.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Ethics Committee of County Emergency Clinical Hospital of Brăila (protocol code 303 from 10 January 2022).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Datasets used in this study are available upon request.

Conflicts of Interest: The authors declare no conflicts of interest.

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