

# Augmented Reality Smart Glasses in Focus: A User Group Report

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## ABSTRACT

Augmented Reality Smart Glasses (ARSG) are a recent development in consumer-level personal computing technology. Research on ARSGs has largely focused on new forms of etiquette for these personal computing devices, but little else has been examined due in part to consumer availability. The most well-known example of ARSGs is Google Glass, which are no longer available for consumer purchase due to privacy concerns. Google has more recently transitioned to industry-focused applications with the Glass Enterprise Edition [1]. Recent consumer-facing iterations on the technology include Snapchat Spectacles and Ray-Ban Stories, which reignite some of the anxieties surrounding wearable cameras. Focals by North, the ARSG product studied in this project, do not have the capacity to record video or audio, thus mitigating the risk of privacy breaches. This study examines how users of Focals employ the device, successfully or not, to facilitate daily activities such as scheduling, communication, wayfinding, and how non-users perceive the interactions of Focals users. Participants wrote blog responses and participated in a focus group on their daily experiences with the glasses; they also speculated on potential uses and features of future iterations relating to accessibility and entertainment purposes. Focals by North, a relatively low-cost ARSG, aims to make this tech mass market to “seamlessly [blend] technology into our world” [2]. However, this study found participants preferred choice when receiving notifications, and greatly questioned the need for notifications to appear in their field of vision. We anticipate that these results will inform frameworks for assessing consumer facing ARSG products in future work.

## KEYWORDS

Smart glasses, augmented reality, field of vision, heads-up display, multi-tasking

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## 1 INTRODUCTION

Augmented Reality glasses, also known as smart glasses, are a relatively new development in consumer-level personal computing. Rauschnabel, Brem and Ro (2015) define smart glasses as “wearable Augmented Reality (AR) devices that are worn like regular glasses and merge virtual information with physical information in a user’s view field” [3, p. 6]. The acronym ARSG (Augmented Reality Smart Glasses) is the standard term for this technology. There are relatively few studies of smart glasses to date, since: a) they are a recent consumer technology; and b) there has been very limited access to the technology.

The best-known product in this area, Google Glass, was widely criticized after its prototype release in 2013, in part due to privacy concerns of those who interacted with users of the product. Although Glass received negative backlash, it succeeded in drawing attention to the emerging market for wearable technology. This is the context in which Focals by North emerged, the ARSG product studied in this project in 2020. Snapchat Spectacles and Ray-Ban Stories (a partnership with Facebook) are two products projected to capture consumer attention in the near future, though they are both primarily marketed as wearable camera devices and working towards fully functional augmented reality experiences [4]. More recently, Google has been in development with their industry facing ARSG technology, Glass Enterprise Edition [1].

This study examines how users of Focals employ the device, successfully or not, to facilitate daily activities such as scheduling, communication, and wayfinding. This study was run through the Critical Media Lab, a cross-disciplinary research-creation initiative out of the University of Waterloo’s English Language & Literature Department. It provides important information about how a novel wearable computing device can or cannot be integrated into daily activities, while also providing information about how non-users perceive its presence in their daily lives. Some of the factors discussed in this study include design, functionality, technology novelty, and speculative uses. Our study provides fine-grained qualitative data about ARSGs based on ethnographic accounts from a student user group, who wore the glasses for three weeks and recorded their experiences in online journals and in a focus group.

In addition to examining the impact of a new wearable technology on the daily lives of users and those with whom they interact socially, this research is interested in how the sociotechnical narratives surrounding wearable devices claim to produce opportunities



**Figure 1: Focals by North version 1.0 with glasses, carrying charger case, and Loop (ring toggle for index finger).**

for users to improve their lives. North’s promotional content, for example, emphasized how Focals would allow users to have respectful and productive interactions with their technology. North positioned itself as a solution to being distracted in the digital world:

“In the short term, we hope that Focals will help you use your phone less. In the long term, we believe they’re the first step toward a new paradigm of technology. One where technology is seamlessly blended into your world - immediately accessible when you want it, but hidden away when you don’t.” [2]

North’s marketing, like content from other wearable tech products, sought to “empower users to make sustained changes in their habits and to experience life more fully” [5, p. 54]. However, our participant group’s experiences with Focals did not align with North’s vision to give users more control over their digital interactions; rather, the glasses were consistently distracting while attending to a task, walking through crowded areas, or interacting with other individuals. To address this discrepancy, this paper will discuss the user group’s experiences, the design affordances of Focals, and the influence of ARSGs in sociotechnical environments with users and non-users alike. This paper also recognizes the development of frameworks for evaluating ARSGs in both industry and consumer facing applications; our case study will be valuable to researchers and designers interested in the potential uses, benefits, hinderances, and concerns about consumer adoption of ARSGs in future work.

## 2 METHODS

### 2.1 Focals by North

Focals by North, hereafter “Focals”, are a relatively low-cost (~\$600) ARSG that were available for purchase from 2018-2020. The Focals, like other ARSGs, feature a holographic image projected onto the interior right lens, visible to the wearer’s right eye. The Focals functioned as a heads-up display through voice controls and a small joystick ring, called a Loop, worn on the user’s hand. The Focals were able to connect with text messages, personal assistant features (ie. Alexa by Amazon), third party applications (ie. Spotify, Uber), and other utilities, such as the date, time, and weather. For this study, six participants used Focals 1.0, which included the glasses, Loop (ring toggle for index finger), carrying charger case, and user’s manual (Figure 1).

### 2.2 Study Demographics

After recruiting graduate student volunteers from the English Department and undergraduate students from the Systems Design Engineering Department at the University of Waterloo, in Ontario, Canada, researchers conducted a three-week study in which volunteers were expected to wear the glasses for approximately three hours a day. There were six participants: two female, one gender non-binary, and three male; two were undergraduate students while the remaining four were graduate students; two were South Asian while the remaining were Caucasian; four were between the ages of 18 and 25, while the remaining two were above 30. There were no exclusion criteria save for availability in the study.

Three participants and two researchers travelled to the North location in Toronto to get fitted for the glasses in December 2019. The remaining participants were sized individually, either at the Toronto location or at the North pop-up shop in Kitchener, Ontario. The glasses are custom fitted to each individual and are not transferrable between users. None were able to use the North iOS application for sizing because it only functioned on an iPhone X, which was unavailable to the participants at the time.

### 2.3 Online Journal and Focus Group Instruments

Over the course of three weeks, participants journaled about their daily experiences, followed by a focus group conducted online. Participants were invited to contribute to a shared Blogger account where they uploaded their daily responses. The participants were not required to respond comprehensively but rather to spend 5-10 minutes each day providing their general thoughts and experiences with the Focals. Eleven blog prompts guided the participants in reflecting upon their experiences regarding their daily use and activities, positive or negative experiences, functionality of the Focals, and interactions with others while wearing the devices.

Following the three-week experiment, participants met virtually for a focus group. The meeting was to be held in-person at the Critical Media Lab on March 20th, 2020, however COVID-19 lockdown procedures and a conflict in schedule required transitioning to Cisco WebEx on March 31st. One participant joined using only the chat function; one joined mainly by chat but spoke without video intermittently; two used only audio; the rest joined with both video and audio. Participants were verbally asked 24 questions under five different subsections to encourage discussion. Researchers recorded the audio and transcribed it using an online transcription service.

## 3 RESULTS

### 3.1 Online Journal and Focus Group Responses

**3.1.1 Time.** Participants were initially asked to wear the glasses for a minimum of three hours per day throughout the study. In their blog entries, participants often described their time wearing the glasses as being “only x-number of minutes because. . .” and never wore the glasses for more than one hour on any occasion. Some of the reasons for their limited use included eye strain, distraction causing lack of productivity, being uncomfortable due to the glasses

overheating, and temporary availability, such as wearing them while in transit.

**3.1.2 Design.** In this study, design refers to the hardware of the glasses, the Loop, and the carrying case. Participants described the design of the glasses by the fit of the frames, the visibility of the display, and the usability of the Loop. In the focus group, participants agreed that they were disappointed by the basic, “prototype” feel of the first generation Focals; one participant noted that it was like reverting to Windows 95 after becoming accustomed to newer operating systems. Participants noted that the appearance of the glasses was highly technical but felt more conspicuous than how they were presented in advertisements. Most of the participants stated that the frames were “clunky,” “awkward,” and “burdensome,” and would sometimes fall off their faces. Some noted that the frames were “objectively unflattering,” “ugly”, and were “not made for a face like mine.”

Regarding the “clicking” auditory feedback of the Focals when navigating with the Loop, one participant found it useful, and even rewarding, to hear the clicks but other participants noted that it was too loud and noticeable to others in their vicinity. Participants expressed interest in the ability to control the volume or turn off this feedback entirely.

The image placement within the lenses was awkward, causing participants to feel cross-eyed or require them to reposition the frames to view the image. One participant was impressed by the image and pixel quality, but another participant found that the text and/or images were too small and blurry for them at times. This difference raised the issue of users with poor eyesight needing to wear contacts under their glasses. One participant questioned the need for a heads-up display at all, noting it has the same function as a smart watch. They suggested that having the image imposed into two eyes would have been preferable, even though they still prefer the functionality of a smart watch because it allows the user to choose whether to check their notifications.

**3.1.3 Functionality.** This study refers to functionality as the software, applications, and general usability of the glasses and Loop. Participants evaluated how well the product operated for them and any obstacles they encountered in attempting to use the Focals.

Functionality was undermined by the limited availability of apps that contributed towards productivity. Most participants found few applications that were useful for them regularly or struggled to install or synchronize the ones they wished to use. They found that the “quick reply texts” came in handy; however, they had issues using Facebook Messenger. Another participant noted that using the Focals with voice command was useful, in particular the voice-to-text function. A participant using WhatsApp said that it worked well and was useful to receive messages in a heads-up display when working with their hands. Another participant attempted to use the to-do list application but had difficulty adding it to their device. In these instances, the participants concluded that third party applications might not be fully integrated into the Focals’ functionality yet.

Privacy and account permissions were another area of concern. An iPhone notification alerted a participant that the Focals had “used [their] location 60 times in the background over the last 3

days.” Feeling unnerved, the participant updated their location settings; however, they later realized that the Focals’ functionality was limited when location data was more restricted. Prior to updating their location settings, this participant enjoyed the feature where, while walking, a review popped up in the lens to inform them about a nearby restaurant. This participant also mentioned concerns about the Focals’ use of an alternate server to deliver text messages rather than being sent from their own phone number. One participant also observed that most of the apps were Google-based, rather than through Apple, which they found inconvenient to register for new accounts in order to get more functionality out of the glasses.

Two participants agreed that the weather application was useful, but one noted that upon asking Alexa for the weather, they received both an auditory and visual response which they found unnecessary and did not improve their experience. Being accustomed to voice command, one participant did not find the visual response to be a significant addition to their experience.

One participant repeatedly struggled with using the alignment application to achieve a comfortable position in their view. They found that even after re-aligning their glasses, they would have to do so again the next occasion they wore them. Three other participants also experienced issues with the alignment process. It is unclear whether this is an issue with the frames not fitting properly, an error in the alignment process, or user error.

All the participants who played the installed trivia and games found them enjoyable. Participants stated that the games were convenient to play while in transit or to pass the time when their attention was not demanded by other activities.

A general comment was that Focals were consistently distracting while attending to a task, walking through crowded areas, or interacting with other individuals. Participants preferred to check their phones for notifications rather than have them in the field of vision. Broadly, functionality was not favorable because of misalignment and general physical discomfort. Participants found that their experiences conflicted with the overall purpose of the Focals presented by North as a solution to distraction and enable individuals to have control over their digital experiences.

**3.1.4 Others’ Reactions.** The participants often received negative or humorous responses to wearing the Focals. Participants found that friends and roommates were initially interested in the glasses and eager to try them out; but they quickly became disinterested. Participants also became bored of re-introducing the glasses to others. Half of the participants who wore the glasses were playfully ridiculed by their peers, who described the glasses as “ridiculous,” “weird,” and “nerdy.” One participant was asked why they “didn’t get frames that suit your face better.” A lone positive response was received from a participant’s mother, who was “amazed” with the Focals.

Peers said that it was obvious when users were engaging with the glasses and no longer attentive to the people or activities around them. The participants were told that they seemed “dismissive” and “disingenuous” while wearing the glasses and interacting with others. Similarly, one participant shared that their partner told them they felt ignored when they were using the glasses. Another participant was told that they looked “cross-eyed” and “walked

differently” when they were interacting with the glasses; indeed, the user felt it took “extra cognitive effort” to multitask between the glasses and other activities.

Participants also made note how others perceived them in the glasses, without having a direct interaction with them. While playing the trivia game on public transit, one participant noted that a nearby individual gave some curious glances towards them. On another occasion, someone mistakenly thought a participant was starting a conversation while they were using the voice-to-text feature.

**3.1.5 Participant Reflections on ARSGs.** In the journals and focus group, participants also shared more general thoughts, questions, or concerns they had during the study, including their thoughts and feelings about the Focals, and being connected in a heads-up display; this led some to reflect on their appearance and identity, as perceived by themselves and others, while wearing the Focals.

During the early days of the study, some participants recorded their excitement about the prospect of the Focals. One participant reflected on how they currently interact with their mobile phone and their expectations for the Focals:

“I’m interested in seeing how life feels with an even more seamless experience of ubiquitous computing. Sometimes I am so absorbed into the content on my phone that I forget I’m even holding a device - mentally, I’m completely enveloped in whatever application I’m using at the time. Will shortening the distance between me and my screen further remove me from reality?”

As the study continued, more participants started to reflect on being constantly connected and, for some, further removed from the world. One participant noted “I like the idea of being disconnected and I do not feel that I will ever feel truly disconnected with these glasses”; another participant similarly found they “often feel not fully present when conversing with others: the frames occupy a portion of [their] awareness in social situations.”

Some participants speculated as to how their work-life balance would be impacted by wearing the Focals regularly. They asked whether receiving constant notifications would normalize an extended workday and make it more difficult to have rest and privacy. Rather than minimizing the time they spent on their phone, the Focals prompted one participant to check their messages more often if they received a notification on the Focals. They recognized that “Yes, I have the option not to check my phone, but it’s much harder when I know that [ . . . ] messages are waiting for me.” This participant concluded that the glasses are “a tool which hinders productivity rather than reinforces it.”

Considering the intent of the Focals and smart glasses technology, participants were conflicted about integrating them into their daily life (see list below). One participant remarked, “Based on Focals’ branding [showing that] they wanted to enable being disconnected from technology, I do not believe the glasses are an adequate solution for that problem.” Similarly, another participant explained, “I’d rather be less functional with my existing glasses or even no glasses because I didn’t have to force myself to be comfortable with something that’s supposed to be fundamental on my body and not an accessory of choice or beauty and style, which didn’t work either.” These comments illustrate the importance of ARSGs being easy to integrate without distraction or discomfort.

**3.1.6 Speculative Uses and Design Exercise.** In both the blog prompts and focus group questions, participants were asked to speculate on what iterations of smart glasses would look like in the next two, ten, and fifty years, including functions that could be integrated with the glasses related to existing hardware, software, artificial intelligence, or network connectivity. The responses did not specifically mention the anticipated time frame of these functions, which included:

- Font resizing or improved clarity
- Automated conversation closed captioning and translation
- Personalized augmented reality for surroundings
- Hands-free AR for task-specific application
- Watching video content
- Increased pixel density
- Fully functioning heads-up display for accessibility
- Ability to watch live or downloadable feeds

Two topics related to functionality emerged from the group’s discussion on speculative designs for Focals: personal and work-related uses. One participant speculated that workers in harsh environments, such as cold or wet climates, might benefit from a heads-up display. If ARSGs could be entirely hands-free, one participant suggested that they would be useful for following instructions while cooking. Similarly, participants discussed how hands-free applications could be useful to paraplegic users or others with accessibility needs. Automated closed captioning for hearing-impaired users or when listening to another language was also suggested as a positive use for the glasses. For leisure purposes, one participant speculated that if the pixel density increased, it would enable more detailed images to be imposed on the lens to the point that a movie or a video feed could be watched through the glasses.

One participant expressed interest in being able to take photographs, livestream, or view live feeds through their glasses. While discussing a camera on the glasses, many of the participants agreed that the associated privacy concerns outweigh any potential positive affordances. One participant imagined that there might be a way of using facial recognition software to indicate to the wearer if someone is telling the truth. All participants responded negatively at the prospect of government and law enforcement using the glasses if equipped with facial recognition software. This discussion led the participants to question North’s target market for the Focals. Considering the potential for issues related to privacy and equity, they came to the consensus that North would benefit from switching from a consumer audience to one for accessibility or industry.

## 4 DISCUSSION

### 4.1 Main Findings

In this research, we conducted a three-week study with six participants wearing Focals by North, a pair of augmented reality smart glasses, which involved them in writing daily journal entries in a shared blog and participating in a virtual focus group. North describes the Focals as an opportunity for “digital experiences that aren’t distracting or overwhelming, but rather utilitarian and respectful” [2]; however, the participants concluded that the Focals are distracting to daily life—distracting enough that they will opt

not to wear them at all. In previous work, researchers have identified some of the key criteria that affect the acceptance of wearable tech: wearability, ease of use, appearance/attractiveness, functionality, enjoyment, and price [3], [6]–[10]. This study discussed some of these factors, such as design, functionality, and others' reactions, and how they helped or hindered participants in their daily activities. Our findings align with previous observations that people want technology that allows them to be present in the physical world while also processing digital information in a virtual capacity [11], [12]. However, whether they were attending to a task, walking through crowded areas, or interacting with other individuals, our participants consistently found that the Focals did not enable them to multi-task or minimize distractions. While industry might improve productivity from ARSGs by applying them in contexts with specific task-based operations, this study demonstrates that the consumer experience, which is characterized by multitasking, could result in the opposite effect.

Our findings also suggest that non-users were significantly impacted by having the device-wearers in their presence. Rauschnabel suggests that ARSGs, as visible consumption objects, prompt others to make assumptions or judgements about the wearer and act as a conversation starter or as a social barrier [13]. Wearing smart glasses may require new forms of social etiquette, as they have the potential to disturb, disrupt, alter [14], or impair social interaction [15]. In addition to receiving criticism on the appearance of the Focals, some participants received feedback from their peers about how the Focals acted as a barrier in face-to-face conversations or made them feel ignored altogether. In one case, a participant opted to not wear the glasses in front of certain people to avoid their disapproval. As Lupton points out, the act of wearing a device itself is a culturally loaded activity that provokes responses from others both positive, like interest or excitement, and negative, like disdain or contempt [5, p. 58]. Scholars note that ARSGs have the potential to influence the conception of the self, the boundaries between people, human agency, dignity, and authenticity [16., p. 29]. We find that the responses from non-users played a major role in the participant's acceptance of the device.

Our results resonate with what Pedersen and Wiberg have previously observed about “seamlessness” being framed as a feature to make computing “friendly” and to promote invasive technologies [16.]. Seamlessness appears only through computing “transgressions” [16, p. 29], such as the technical difficulties with connectivity and image alignment experienced by our participants. One participant questioned whether the “seamless experience of ubiquitous computing”, in the form of the Focals, would remove them further from reality than they already felt when using a smartphone. As the market for ARSGs expands, along with other wearable devices, we see more of what Wiberg describes as seamlessness, or the body itself as interface: “[Our] gestures, our bodies, our eyes, our skin, our position, or even our fingertips can do the job [interacting with computers] for us” [17]. In research on wearable fitness trackers and sleep monitoring devices, Lupton finds that “the ubiquitous, mobile, and intimate affordances of wearables that are promoted so enthusiastically by their developers can be experienced as intrusive” [5, p. 62]. If companies are to accomplish this seamless connection, they must improve upon the technical issues that interrupt the user's experience.

Improving the functionality of Focals could improve its acceptance. Broadly, the participants agreed that the Focals did not add significant value to their daily lives and suggested that future iterations be developed with more targeted functionality and specific audiences in mind. In the speculative design exercise, the focus group imagined future uses or iterations on the Focals that would improve the general functionality of the Focals, such as increased text size and automated closed captioning. They also discussed the potential for ARSGs equipped with cameras to be used for livestreaming or facial recognition applications. Although Focals 1.0 did not have this capability, it was revealed in early 2020 that Focals 2.0 would have a camera. Participants responded negatively to the prospect of this technology being used by government or law enforcement. Previous research has delved into these concerns, suggesting that there is potential for ARSGs to be used to nudge or direct people's attention, intrude into the physical and emotion space of users, and contribute to the expansion of the surveillance state [16.]. Participants speculated that ARSGs would be useful to people with physical impairments or workers in specific industry contexts. In 2014, ARSG researcher Brian Due projected three types of applications for smart glasses: “1) specific job-related applications, 2) task-related and professional, contextual applications and 3) lifestyle applications for so-called self-trackers” [10]. To date, there has been research on integrating smart glasses technology in automotive, retail, manufacturing, and medical industries [11][18-22].

Within the last decade, smart watches and other self-tracking devices have become mainstream but ARSGs have not yet gained traction at the consumer-level [23]. After this study, North announced they had been acquired by Alphabet and production on Focals 2.0 had ceased indefinitely [24]. More recently, Google turned its attention to augmented reality for industry with their Glass Enterprise Edition [1]. Despite the tech industry's interest in ARSGs and the potential applications, our findings suggest that one of the foremost obstacles for mainstream adoption of ARSGs lies in the consumer finding the necessity and desire to receive information in front of their eyes.

## 4.2 Limitations

The COVID-19 public health measures introduced in March 2020 changed the frequency and nature of the interactions, limiting the generalizability of the study. In the first two weeks of the study, participants were able to go out in public safely until lockdown measures were enacted at the University of Waterloo. In the third week, it was more complicated for participants to sustain participation under the guise of their daily lives. The lockdown also limited the range of interpersonal experiences with the Focals by restricting the number of contacts each participant could interact with during the study, and by narrowing social settings to the immediate household and virtual conference calls. As a large component of this study was to perform hands-on workshops, including exercises with printed speculative design prompts in a group setting, physical distancing measures greatly limited the speculative design elements of the results.

Sample size and composition further limited the generalizability of the study. By enlisting students predisposed to thinking critically

about technology from English and Engineering backgrounds, this study captured a limited scope of North's intended target market.

The cost of the Focals (~\$600 CAD) for each participant and the two research assistants was covered by a research grant, which did not provide participants with perspective on price as a factor to weigh against the perceived value of their experiences with the Focals.

### 4.3 Future Research

Future research could involve recruiting a different set of participants to use the glasses, but the glasses only work for the individual who purchased them. While the customization of the glasses offers a bespoke experience for individual users, it also means that the technology cannot be transferred between users. This raises some environmental concerns associated with Focals. Since each pair of glasses are custom fitted to individual users, the glasses lack sustainability, and they have effectively become e-waste, the fastest growing waste stream in the world [25]. Future studies of AR Glasses might focus on the sustainability of the product, careful not to contribute to rates of disposable electronic equipment. Product design itself might look at transferability between users and options for recycling and/or upcycling the product.

Key takeaways from this study include four of the main themes that emerged from the participant responses – time, design, functionality, and others' reactions – which would inform factors to be considered within a practical framework for assessing consumer ARSGs. A handful of researchers have been working toward evaluative frameworks for ARSGs in industry [18-22]; related more closely to our work, Han et al. have explored ARSGs in cultural tourism contexts, proposing a framework which integrates societal impact, perceived benefits, perceived attributes of innovation, and visitor resistance [26]. We recognize the emerging interest in developing assessment frameworks and the divergent interests and priorities of industry versus consumer ARSG designs; to this end, our case study provides insight into consumer preferences that illustrate the needs and obstacles of the everyday user.

Our case study considers not only individual user experiences but also the users' interactions with non-users, keeping in mind the "glasshole" effect caused by what might be called "technological asymmetry" (haves and have-nots). Embedded in the concept of technological asymmetry is access to information, which we could further refine as "information asymmetry" [27]. Our research has shown that in the case of AR Glasses, information asymmetry raises the issues of privacy (non-users may feel infringed upon) and presence (non-users may feel as if they are competing for users' attention). The glasshole effect can result in both a negative response to the product user but also a backlash against the technology itself. For these reasons, the study of non-users is an important consideration for new frameworks [28], [29] and it could certainly help determine the potential for widespread adoption of new wearable AR products.

Finally, our study considers the exclusiveness of the product and asks users to consider how those who would likely not have access to the glasses might make use of them. This raises the issue of technological accessibility, including socioeconomic factors that financially determine ownership of gadgetry as well as issues of

race, gender, and physical ability that may impact adaptation of a new product such as AR glasses. Future studies of AR glasses could expand on the themes we have proposed to further develop these accessibility considerations in the design, use, and reception of technological innovations.

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