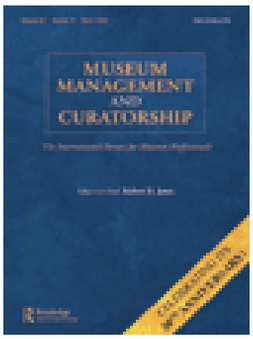

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'I felt I was right there with them': the impact of sound-enriched audio description on experiencing and remembering artworks, for blind and sighted museum audiences

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ABSTRACT

This study explored the impact of sound-enriched audio descriptions (AD) on the experience and memorability of a digitally presented photography exhibition. Forty blind and partially blind (BPB) and forty sighted participants were presented with eight photographs from the Museum of London's archive. Four photos were presented with a standard audio descriptive guide (ADG) and four with a sound-enriched audio descriptive guide (EDG). Experience and memorability were assessed directly after the presentation, and approximately 4 weeks later. Results demonstrated that sighted people remembered more photos than BPB people did with ADG. However, when photos were presented with EDG, the BPB and sighted groups remembered equal number of photos and equal numbers of details. EDG was also enjoyed and preferred by both BPB and sighted participants. Findings suggest that EDGs could be used within mainstream museum offerings as inclusive audio interpretation, thus enhancing access and enjoyment for many visitors and facilitating shared experiences.

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Museum interpretation; access; memory; visual impairment; multisensory; inclusive design

Introduction

There is one very powerful implicit assumption that underlies the design and programming of the vast majority of visitor experiences in museums: that fully sighted visitors can access collections through vision. This fundamentally ocular-centric bias results in the creation of a binary relationship between the 'normally' sighted visitors and the 'other' blind and partially blind visitors who have additional access needs (Eardley et al. 2022).

Audio description (AD), traditionally understood as a 'translation' of visual information into verbal description (Fryer 2016; Jiménez Hurtado and Soler Gallego 2015), is a tool used to provide access to 'visual' content for blind and partially

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blind audiences. In museums, AD is generally takes the form of recorded audio descriptive guides or a live tour with an audio describer, sometimes with contributions from a curator. To date, AD in museums has traditionally been considered a specialist provision, required for blind or partially blind visitors for whom access through vision is limited or unavailable. Although AD is understood to be crucial for BPB audiences, numbers of potential visitors are considered to be small, and as a result, where available at all, descriptive tours may only run once per exhibition, must generally be booked in advance, and the availability of recorded audio descriptive guides is low, with only 3% of museums and galleries in the UK mentioning such guides on their websites (Eardley et al. 2022).

However, a growing number of researchers and practitioners are challenging the assumption that having vision automatically provides 'access' to museum collections (e.g., Chottin and Thompson 2021; Eardley et al. 2017; Hutchinson and Eardley 2021). Museums present a visually demanding environment, where multiple exhibits, objects and displays compete for visual attention (Bitgood 2013). Research has demonstrated that sighted visitors tend to look only fleetingly at individual exhibits or artworks, with researchers noting average dwell times of under half a minute (Smith and Smith 2001; Smith, Smith, and Tinio 2017). This raises the question of what level of engagement can take place within a short duration of looking. Furthermore, expert and novice museum goers look differently at artworks: art experts are more likely to scan for composition and form, whereas art novices focus their attention on recognisable objects (Koide et al. 2015). Thus, the assumption that access to museums rests primarily on the visual sense is problematic, in view of the brevity and variability of sighted visitors' visual attention.

Sighted visitors may benefit from support with guiding their vision, just as support is necessary for blind and partially blind visitors to access the museum. Audio Description has been posited as an opportunity to offer both 'guided looking' for sighted people, and, simultaneously, access to the museum experience for BPB people (Eardley et al. 2017). When used by people with full or partial sight, AD helps to direct the gaze around the visual features and layout of the artwork or exhibit. The AD user simultaneously hears a description of those features, alongside factual, historical or contextual information. The congruence of visual and auditory information may thus allow for a deeper level of cognitive processing, which may enhance memorability (Craik 2002). Linguistic features of AD may further promote deeper engagement and subsequent richer memories, through the use of narrative and thinking prompts (Hutchinson and Eardley 2020; Neves 2012). Such techniques may increase emotional engagement, interest and curiosity, which are known to enhance memorability (Kang et al. 2009; Renninger and Hidi 2015). Furthermore, AD practice typically encourages the use of multisensory imagery in AD texts (Hutchinson and Eardley 2020). Mental imagery is quasi-perceptual experience which resembles perceptual experience but takes place without the external stimuli (Cattaneo et al. 2008; Kosslyn, Behrmann, and Jeannerod 1995), for example imagining the sight, feel, smell or taste of an apple without having physical access to one. AD often seeks to stimulate such imagery across sense modalities, to enhance the user

experience. The generation of mental imagery is known to enhance memorability (Williams, Healy, and Ellis 1999), across modalities and irrespective of visual experience (Eardley and Pring 2006).

Thus, AD stands to promote a richer mode of access through stimulating thoughts, feelings and imagination. Although AD is typically understood as a visual to verbal 'translation' (Fryer 2016; Jiménez Hurtado and Soler Gallego 2015; Snyder 2014), it should facilitate access to a museum experience, thereby going beyond the provision of visual information (Hutchinson and Eardley 2018, 2022). Analysis of people's memories of museum visits demonstrates that what is seen or even learnt in the museum makes up just one part of a multifaceted experience (Anderson 2003; Anderson and Shimizu 2007; Dierking and Falk 1992; Hutchinson, Loveday, and Eardley 2020; Falk 2013; Medved, Cupchik, and Oatley 2004; Medved and Oatley 2000). Hutchinson, Loveday, and Eardley's (2020) analysis of visitors' memories demonstrated a hierarchy of content, with memories being formed of knowledge acquired during the visit, contextual information relating the visit to visitors' own lives, emotions and thoughts, sensory-perceptive information, specific events that took place, details of the museum space, and social interactions. As such, visual information is evidently only one aspect of the museum experience. AD, therefore, can seek to facilitate many things in the museum: it will provide access to visual information, but can also explore meaning, arouse emotion, stimulate mental imagery: all through its provision of narrative and enriching factual or contextual information.

The possibility of AD as a mode of access to a richer museum experience has been supported by empirically driven research. Sighted participants viewed a series of photographs from the Museum of London's collections presented in a digital format, and a comparison was made between the use of an audio descriptive guide (AGD), a traditional audio guide and visual exploration alone (Hutchinson and Eardley 2021). All three modes of access were equally enjoyable and engaging for the participants at the time of experiencing. However, one month later, participants who used an audio guide, either traditional or descriptive, remembered more photos than those who just looked. They were also more likely to have re-engaged with the collection. Importantly, those who listened to an ADG when viewing photos demonstrated richer memories of the artworks. They not only recalled more visual details such as the content elements of the photos and their spatial arrangement, but also recorded more thoughts and emotional reactions to the artworks, suggesting a deeper engagement and a more long-lasting impact. These recent findings for AD support the notion that services developed as access provisions may provide benefit for groups for whom they were not originally designed (Chottin and Thompson 2021; Hutchinson and Eardley 2021), and that AD could be repositioned as a form of inclusive interpretation, which could benefit many visitors.

The present study sought to build on these promising findings by exploring an aspect of AD design which could further enhance the AD facilitated experience, namely sound enrichment. It could be argued that sound enrichment is a form of subjective interpretation, which is something that traditionally AD guidelines have advised against (RNIB 2010; Snyder 2014). However within Museum AD, there is recognition

that the objectivity principle is challenging when applied to a museum experience (Adlab Pro 2022; Fryer 2016; Hutchinson and Eardley 2018; Kleege 2018; Mazur and Chmiel 2012; Neves 2012, 2016). Theory from cognitive psychology supports the case for congruent sound enrichment, with research demonstrating that the use of multisensory stimuli enhances memory (Gottfried et al. 2004; Lehmann and Murray 2005; Nyberg et al. 2000) and that the greater the level of congruency of multisensory stimuli, the greater the benefits (Kim, Seitz, and Shams 2008; von Kriegstein and Giraud 2006).

Through layering meaningful sounds onto an AD track, the blind or sighted AD user is exposed to additional sensory input that may stimulate attention, interest and imagery generation (Bitgood 2013; Bubaris 2014; McCarthy et al. 2004; Renninger and Hidi 2015). Increased image generation may create further connections within the listener's networks of existing semantic knowledge and memories, a process known as elaboration (Craik 2002). A greater degree of elaboration stands to allow a deeper level of processing which may in turn contribute to increased memorability (Craik 2002). A study conducted in radio, where there is also no visual perception, has hypothesised that the use of sounds creates a richer sensory experience that may help to generate mental imagery. Rodero (2012) compared audio drama with/without additional sound effects, and found that sound helped to increase mental imagery, as self-reported by participants through established imagery questionnaires. Additionally, the study found a relationship between the generation of mental imagery and increased attention, as demonstrated through correlation analysis.

It has been argued that additional perceptual experience and stimulation of imagination through sound may not only heighten the experiential nature of being in a museum but also help the visitor to imagine being in a different place or time (Bubaris 2014). This is likely to be particularly valuable to blind users whose access to the artwork may otherwise be entirely mediated through language. Sound enrichment offers these AD users a sensory interpretation that provides a direct perceptual experience.

It has been suggested that the use of sounds in museums enhances emotional engagement with the visit (Bertens and Polak 2019; De Jong 2018; Marshall et al. 2016). Furthermore, it may increase empathy, enabling the visitor to feel more connected to people from another time or place (De Jong 2018). The use of sound therefore supports a growing emphasis on experience in museums, where 'feeling' is rivalling the traditional emphasis on 'learning' (De Jong 2018; Radder and Han 2015). Empirical research testing the ability of sound to arouse emotion in museums is limited, although some qualitative analysis suggests that the use of sound can increase visitors' emotional engagement (Bertens and Polak 2019; Marshall et al. 2016). However, the relationship between sound and emotion has been demonstrated in other fields, such as in film research where environmental and ambient sounds have been linked to increased emotion (Weninger et al. 2013). Emotion is also known to enhance memorability, as the moments we recall most vividly are often those where heightened emotion was presented (Holland and Kensinger 2010).

Thus, both the psychological literature and the museum literature indicate that the use of sound may increase emotion, attention, interest and the generation of mental imagery, all of which stand to enhance memorability and impact. The use of sound in AD is to date under researched. While the idea of adding sound to AD is not new, empirical explorations of the use of sound in AD are rare. Fryer, Pring, and Freeman (2013) explored the impact of sounds in an audio drama on measures of presence, the feeling of being in the meditated environment, with both blind and sighted people. Sound effects increased ratings of spatial presence and ecological validity in sighted people, but no effect was found for blind participants. The authors suggest that the effort needed to assimilate sounds into a mental model of the scene may have reduced the sense of presence for blind participants. However, the lack of benefit for blind AD users may be specific to the measure of presence, and may not preclude other benefits, including memorability. Furthermore, the use of sound in the museum context may be received differently. Benefits in museum AD have been anecdotally reported by practitioners (Eardley et al. 2017), and the use of sound in museum AD is promoted in some training guidelines (Giansante 2013).

The focus of this research is on inclusive AD, and as such seeks to understand the experiences of BPB and sighted participants. It is important to acknowledge that research has suggested there may be underlying differences in autobiographical memory generation between BPB and sighted people. Tekcan et al. (2015) compared autobiographical memories cued in sighted and blind participants, where the blind participants were either congenitally blind or early blind (lost vision within the first year of life). The blind participants had either no light perception, or light sensitivity but no pattern perception. The authors reported that blind participants generated fewer memories in response to cue words, compared to sighted participants. They suggested that the visual sense is the most important in integrating components of memory both at encoding and later rehearsal. However, these findings sit in contrast to those of Eardley and Pring (2006), who found no differences in autobiographical memory generation in congenitally blind and sighted participants in response to multisensory cue-words. Eardley and Pring (2014) offer an alternative explanation; that sighted people are more likely to have multisensory imagery, as images that they generate across modalities are almost always accompanied by a visual image. As a result, autobiographical memories for people with vision are probably more likely to be multisensory, and that multisensory input is likely to make those memories easier to recall. If autobiographical memory retrieval is lower in blind people compared to sighted people, then this may reduce the number of memories retrieved by BPB people overall.

This study is the first empirical exploration of the impact of sound enriched audio descriptive guides (EDGs). It addresses the research question of whether the EDGs would impact on the experience and memorability for sighted and blind participants. It thus addresses an important gap which is needed to drive AD development and its use as inclusive interpretation in museums. It was expected that the use of sound would impact positively upon the experience and engagement in both groups. BPB participants were also expected to display better recall with sound enriched AD than with standard AD, due to the additional layer of perceptual experience. The recall of sighted participants was also expected to be enhanced with sound, if the additional perceptual experience is able to increase imagery or increase attention/

interest/emotion enough to enhance memorability. It was however possible that BPB participants would present with lower recall overall at time B than sighted participants, due to potential differences in autobiographical memory retrieval between the two groups.

Methods

Design

The study was a longitudinal mixed design. The between subjects factor was vision group (BPB, sighted). Within subjects, factors were AD type (ADG, EDG) and time (time A – directly after the presentation; time B – one month later). A series of dependent variables were examined; the overall experience (enjoyment, engagement) was measured at times A and B, and memorability was measured at time B. Where data were not normally distributed, and normality could not be achieved using transformations, non-parametric tests were used. All tests were two-tailed.

Participants

Forty BPB people and forty sighted people took part in the study. One participant in the sighted group did not complete the follow up and was therefore excluded from the analysis. Within the BPB group, the mean (SD) age was 50.39 (15.04); 23 males, 17 females. In the sighted group, the mean (SD) age was 50.64 (15.53); 22 males, 17 females. Participants were matched for age within 5 years and an independent *t* test confirmed no difference in ages between BPB and sighted groups: ($t = 0.074$, df = 76, p = .94). Within the BPB group, 16 participants described themselves as having no useable vision, 22 as having some useable vision, and 2 as having considerable useable vision. An additional scale was selected which has been used to measure self-reported levels of functional vision (Pavey, Douglas, and Corcoran 2008; see also Fryer 2013). Based on this scale, all 40 BPB participants would require assistance to access museum exhibits, which are often displayed from some distance. Five participants in the BPB group and three in the sighted group were non-native speakers of English; all eight described themselves as bi-lingual or fluent. The study received ethical approval from the University of Westminster's Psychology Ethics Committee and was run in accordance with the British Psychological Society's ethical requirements. All participants gave informed consent, were debriefed upon completion, and offered a £15 shopping voucher as a thank you for their time and contribution.

Materials

Eight photos were selected from the Henry Grant Collection at the Museum of London. All were taken outside, were black and white, contained people but with a clear focal point and all taken between 1950 and 1970. An example is shown below.

Children playing in the Lido in Parliament Hill Fields, Hampstead Heath, 1957. © Henry Grant Collection/Museum of London

The audio descriptions previously developed by the authors for use with these photos (Hutchinson and Eardley 2021) provided the ADG condition. For the EDG condition, soundscapes were created for the photos and added to the AD files. The recorded audio descriptions were edited by the first author using Audacity software (version 2.2.2) to apply sound effect files sourced via the National Theatre or via online resources such as the BBC Sound Effect archives. Where possible, sound was given a spatial element congruent with the image, such as footsteps walking from left to right.

Measures

Two questionnaires (time A, time B) were designed for the experiment; one administered in person after the participants had viewed the photos and the second completed online via a Qualtrics link, or by phone, one month later. The questionnaire at both times A and B (available from the corresponding author on request) addressed the participant's experience and engagement levels, with the questionnaire at time B also addressing memorability for the photos.

The questionnaires collected the following information:

Demographic data

Age, gender, level of vision (Pavey, Douglas, and Corcoran 2008; see also Fryer, 2013), whether English was the participant's first language, with level of English rated on a 5-point scale if applicable. Participants rated their museum visiting habits over the last 5 years on a 5-point Likert Scale (1 = never, 5 = once a week or more).

Experience and engagement

Participants' attention was measured by logging the time spent on each photo in seconds. Participants rated their enjoyment of the overall experience on a 7-point Likert scale ranging from 'hated it' (1) to 'loved it' (7), at both times A and B. They were asked whether any personal memories came to them during the exhibition at time A, and if so, they were asked to rate them for vividness. At time A, participants were asked to select the photo they found the most/least interesting. To address the audio experience, participants were asked at time A whether they noticed the enrichment using sound effects in some of the photo presentations, and if they answered yes, they were asked to describe any impact it had on their experience in a free text response, which underwent thematic coding by the first author. They were then asked to state whether they preferred the ADG, the EDG, or whether it made no difference.

Memorability measures

At time B, participants were asked to recall the photos and provide as much detail about them as they could in free text responses. This photo recall text was then coded across seven categories. Five of these were the same as categories used previously (Hutchinson and Eardley 2021): spatial; event/activity/movement; emotion and atmosphere (including non-visual imagery); participants' reactions (including emotions, thoughts, and memories mentioned during photo recall); and semantic recall (including socio-historical information/context and information about the photographer). Auditory imagery and references to sound were a separate category. A 'content' category included content elements that could be recalled from seeing the photo or listening to the audio (e.g., one count attributed to 'there was a boy'). The categories were combined to give each participant a score for the total details they recalled for both the ADG and EDG photos.

Procedure

All participants took part in the study in a quiet room with no external distraction. The eight photos, four of each photo type, ADG and EDG, were presented on a laptop computer in a PowerPoint presentation with a minimum screen of 13.5 inches. The order of the photos and photo type were randomised. Audio was played through headphones, with volume checked by the participant. Participants were told that they could listen to the full duration of the audio file if they wanted to, or move on sooner if they chose, and that they would have a chance to re-visit any photos at the end if they wanted to. After the presentation of the photos participants completed the Time A questionnaire. This was done either online (Qualtrics) with the aid of a screen-reader if necessary, via large-print questionnaire or via recorded dictation to the researcher, with the recordings later undergoing professional transcription. A month later, the time B questionnaire was

either completed by phone, in which case calls were recorded and professionally transcribed, or online via Qualtrics.

Results

Participant demographics and time taken to follow up

Mann-Whitney U tests confirmed no differences between the BPB or sighted groups of participants in terms of their enjoyment of museum and gallery visiting ($U = 664.50$, $N_1 = 40$, $N_2 = 35$ $p = .68$); although sighted participants had visited museums more frequently in the previous 5 years: ($U = 521.00$ $N1 = 40$, $N2 = 39$, $p = .008$).

There was no difference between the time taken between completion of the Time A questionnaire and Time B follow-up questionnaire ($U = 733$, $N_1 = 40$, $N_2 = 39$, $p = .64$), where BPB participants took mean 35.78 ($SD = 7.15$) days and sighted participants took 35.10 ($SD = 5.21$) days.

Results relating to the overall experience

Listening time. In the BPB group, the mean (SD) total photo presentation time was 30 minutes and 51 seconds (3.81 seconds). In the sighted group, it was 30 minutes and 52 seconds (5.20 seconds). A Mann-Whitney U test confirmed there was no difference in the total presentation time for BPB or sighted: ($U = 665$, $N_1 = 40$, $N_2 = 39$, $p = .26$). Analysis was conducted on the number of participants who chose to listen for less than the total available audio time. 19% of BPB participants listened for less than the total available time, and 34% of sighted participants. A Pearson chi square analysis confirmed no differences between the two groups: (chi-square = 2.19, $p = .14$).

Enjoyment. Table 1 indicates that the overall enjoyment in both groups was high. At time A, a Mann-Whitney U test confirmed that BPB rated their enjoyment slightly higher than sighted participants: ($U = 544$, $N_1 = 40$, $N_2 = 39$, $p = .009$). Over time, enjoyment ratings for sighted people appeared to remain stable at time B (Wilcoxon: $Z = 1.70$, $p = .09$). But ratings for BPB participants dipped between times A and B: ($Z = -2.50$, $p = .012$), such that levels of enjoyment at time B were the same for BPB and sighted participants: (Mann Whitney $U = 583.50$, $N_1 = 40$, $N_2 = 39$, $p = .063$).

Comparing EDG and ADG

Interest. Participants were asked to select the photo that they found 'most interesting' and the photo that they found 'least interesting'. Some photos were selected more often than others, however each photo appeared at least once in both the 'most interesting' and 'least interesting' categories.

Table 2 suggests that both sighted, and to a greater degree, BPB participants were more likely to select an EDG photo as the one they found most interesting. Binomial

Table 1. Enjoyment ratings (median, range) at times A and B, where the maximum score is 7.

	Enjoyment rating time A	Enjoyment rating time B
BPB participants	7 (2)	6 (3)
Sighted participants	6 (3)	6 (4)

Table 2. selection of most and least interesting photos: proportions with ADG and EDG, by participant group.

		BPB group	Sighted group
'most interesting' Photo	ADG	27%	36%
	EDG	73%	64%
'least interesting' Photo	ADG	63%	54%
	EDG	37%	46%

tests confirmed that more BPB participants chose an EDG than an ADG photo for the 'most interesting photo': EDG choice = 29, ADG choice = 11, $p = .006$. For sighted participants, there was no difference: EDG choice = 25, ADG choice = 14, $p = .108$. For the choice of least interesting photo, there were no differences between the numbers of photos chosen with EDG or ADG for either BPB ($p = .15$) or sighted ($p = .75$).

Participants also stated at times A and B which audio they preferred, or whether it made no difference. The majority of participants preferred listening to the EDG audio at time A; and audio preferences remained broadly consistent across both groups at time B (see Table 3). A binomial test analysis was conducted for each participant group in order to explore whether there was a significant difference between the numbers of participants who preferred ADG or EDG. The participants who selected 'it made no difference' were omitted from this analysis, three BPB and three sighted participants at time A, and one BPB participant and five sighted at time B. The binomial analysis was significant at time A for both groups: BPB $p = .001$, sighted: $p<.001$ and at time B: BPB $p = .003$, sighted, $p = .001$. This indicates that significantly more participants in both the sighted and BPB groups preferred EDG.

At time A, participants were also asked whether they noticed the sound effects, and if so, what the impact it had (if any) on their experience. All participants confirmed that they noticed it. Their observations were broken down further thematically to explore the content of what was said. This thematic coding was conducted by the first author. The most important theme was one of a sense of immersion. This included comments about the photos being brought to life by the enrichment, about the participant feeling present in the scene, or about the enrichment helping them to imagine it. Forty-three such comments were made by 23 BPB participants (58% of sample), and 30 comments were made by 25 sighted participants (64% of sample). Examples included: 'it just transported me actually into the scene itself. It felt more realistic' (BPB participant); 'the background sounds made you feel as if you were right there with them' (BPB participant); 'The sound effects made the pictures come to life; made them seem more real. I felt that I could almost imagine myself being there' (sighted participant); 'It positioned me in the photograph, giving each experience a sense of immediacy and urgency' (sighted participant).

Table 3. Audio preferences (percentages) by participant group (BPB, sighted) at times A and B.

	Time A			Time B		
	EDG	ADG	Made no difference	EDG	ADG	Made no difference
BPB participants	73%	20%	7%	73%	25%	2%
Sighted participants	74%	18%	8%	69%	18%	13%

The next most prevalent observation was that it enhanced the experience. Such observations were expressions of enjoyment and interest, including observations that the enrichment added atmosphere and helped tell the story. There were 37 comments in this category from 24 BPB participants (60%), such as 'it made it more interesting' and 'it made me smile' and 21 comments from 17 sighted participants (44%); 'it made it more lively', and 'each photo had a story to tell emphasized by the sounds'.

Eight participants, four in the BPB group (10%) and four in the sighted group (10%), made the observation that the enrichment helped them to concentrate and helped to focus their attention, with two sighted participants stating that the sound effects highlighted aspects of the photos that they would otherwise have missed. Five BPB participants and one sighted participant commented that the enrichment either evoked memories or would help them to recall the photos later, and seven participants (five BPB and two sighted) likened the experience of listening to the EDG to cinema or film.

Negative observations from 10 BPB participants (25%) and eight sighted participants (21%) were similar for both groups; namely that the enrichment was distracting, unnecessary or irritating if it did not match with the participants' imagined versions of how the sounds should be. Seven BPB participants and two sighted participants suggested ways in which they would change the enrichment, such as shortening the duration of the sounds, ensuring they were used only during a pause in the words, or making them quieter. This analysis demonstrated a very similar, positive response to the use of enrichment with both BPB and sighted people, although the BPB participants recorded more thoughts overall than sighted.

Autobiographical memories

One hundred and six autobiographical memories were recorded by participants in response to the free text question 'During the exhibition, did any memories come to mind?', of which 71 (67%) were from the BPB group and 35 (33%) from the sighted group. In the BPB group, the mean (SD) number of memories was 1.78 (1.25) and in the sighted group it was 0.90 (1.02). A Mann Whitney U test confirmed that there were significantly more memories in the BPB group: ($U = 441.50$, $N_1 = 40$, $N_2 = 39$, $p = .001$).

In the BPB group, 38 memories related to EDG photos and 33 to ADG photos. In the sighted group, 15 memories related to EDG photos and 20 to ADG photos. Wilcoxon tests confirmed no difference in the numbers of memories generated in response to EDG and ADG photos for either group: for BPB ($Z = -0.51$, $p = .61$), for sighted ($Z = -9.7$, $p = .33$). In other words, BPB participants recorded more memories than sighted participants, but similar numbers of memories were evoked in response to both ADG and EDG photos in both groups. If participants reported memories, they were asked to rate the vividness of the most vivid memory. For BPB participants, the median (range) memory vividness rating was 9.5 (8); for sighted participants, it was 8 (8). A Mann Whitney U test confirmed there the BPB group's memory vividness was significantly greater than the sighted participants: ($U = 370$, $N_1 = 36$, $N_2 = 29$, $p = .04$). Taken together, this suggests that BPB participants were not only more likely to make associations from the artworks to their own lived experiences, but also, that those associations were more vivid.

Memorability measures

At time B, BPB participants recalled a mean (SD) number of 2.08 (1.38) ADG photos, and 2.48 (1.22) EDG photos. Sighted participants recalled a mean (SD) number of 2.79 (1.20) ADG photos, and 2.72 (1.19) EDG photos. Wilcoxon tests confirmed that more EDG photos were recalled than ADG photos in the BPB group: ($Z = -2.15$, $p = .031$) and that there was no difference between the amount of EDG and ADG photos recalled in the sighted group ($Z = -0.323$, $p = .75$). Mann-Whitney U tests confirmed that more ADG photos were recalled by sighted than BPB participants ($U = 548.50$, $N_1 = 40$, $N_2 = 39$, $p = .02$) but that there was no difference in the number of EDG photos recalled in either group: ($U = 682.00$, $N_1 = 40$, $N_2 = 39$, $p = .32$)

The memories were coded for details, resulting in a total details score for ADG photos and a total details score for EDG photos, for each of the sighted and BPB groups. Some participants recalled a memory in only one condition, but not the other. Two BPB participants recalled details for ADG photos only, and seven recalled details for EDG photos only. In the sighted group, one participant recalled details for ADG photos only. Two sighted participants recalled no photos at all and were therefore excluded from this analysis. Data of those who only remembered content from one condition were included in the analysis, but the result was that the data was not normally distributed, so nonparametric inference tests were used, with a Bonferroni-Holm correction for multiple tests.

In the BPB group, the mean (SD) total details scores were 24.65 (22.00) for ADG photos and 30.30 (26.50) for EDG photos. In the sighted group, the mean (SD) total details scores were 37.12 (30.38) for ADG photos and 37.92 (31.64) for EDG photos. Wilcoxon tests confirmed no differences in the number of details recalled for ADG or EDG photos either in the BPB group: ($Z = 1.68$, $p = .19$); or in the sighted group: ($Z = 0.369$, $p = .71$). Therefore, participants in both groups recalled similar numbers of details for photos regardless of the AD type. Mann-Whitney U tests were also conducted to explore potential differences in recall of the details between groups. There were no differences between the sighted and BPB groups for the number of details recalled for either ADG photos ($U = 541$, $N_1 = 40$, $N_2 = 37$, $p = .084$) or EDG photos ($U = 617$, $N_1 = 40$, $N_2 = 37$, $p = .21$).

Discussion

This study was the first to evaluate the impact of sound-enriched museum audio description on the experience of BPB and sighted audiences. The findings demonstrated that the EDG was preferred by BPB and sighted audiences. Furthermore, whereas sighted participants remembered more photos presented with ADG, that memory advantage disappeared for EDGs. Taken together, experience and memorability all build a clear case for offering EDGs as an interpretation option for all visitors in museums.

Building on Hutchinson and Eardley (2021), this study also informed on the similarities and differences between BPB and sighted participants in terms of the AD experience. Enjoyment levels were high in both groups, with median ratings of at least 6 ('I liked it a lot'). There were also no differences between participant groups in terms of attention, as demonstrated by the listening time. This study adds support to existing empirical findings that suggest AD can be enjoyed by all as a form of inclusive interpretation (Hutchinson and Eardley 2021).

The EDG was well received by both sighted and BPB participants, with a preference for sound enriched AD in both groups. This preference suggests that EDG had the advantage over ADG in terms of enhancing engagement. A stronger impact of EDG was also evident in the BPB group, where participants were more likely to select an EDG photo for their choice of 'most interesting' photo. It is possible that the use of sound had even more impact on interest levels for BPB participants, as it provided them with a perceptual experience of the photos which was not available through ADG. The preference for sound enriched AD, regardless of levels of vision, adds support to the qualitative observations and discussion in the museum literature, focused up to now on sighted visitors, about the benefits of sound on museum experience (Bertens and Polak 2019; Bubaris 2014; Marshall et al. 2016), including increasing enjoyment (Ardito et al. 2012; Bertens and Polak 2019).

Thematic analysis of the qualitative comments on sound enrichment within this study helps bring colour to the quantitative measures. It was noteworthy that the breakdown of comments was broadly similar in both participant groups, suggesting a consistency of experience, independent of levels of vision. The most prevalent theme was that of feeling immersed, with the enrichment bringing the photo to life or helping the listener to feel present in the scene. This differs from the findings on presence in audio drama (Fryer, Pring, and Freeman 2013) and whilst these observations are qualitative in nature, they would merit further exploration. Future research could use measures of presence to further evaluate the immersive potential of sound enriched AD in museums.

Although the prevalence of negative comments was relatively low in this study, it is important to acknowledge that some people, both BPB and sighted, did not enjoy the sound enrichment, with comments indicating that the sounds were distracting or unnecessary. This serves to re-emphasise the importance of choice of mode of delivery in museum interpretation, and in audio in particular (Woodruff et al. 2001), so that visitors can select interpretation that fits their own preferences. Similarly, the data showed no difference in the numbers of BPB and sighted participants who chose to listen to the complete audio description. However, three people in each group did choose to listen to less than 75% of the total available audio, suggesting that choice in duration of audio would also be beneficial.

Audio guides in general have been criticised for their potential to impede the visitor's ability to enjoy the exhibits with full independence of thought (Bauer-Krösbacher 2013). If the audio is 'taking over', then this would suggest a corresponding reduction in personal response to the artworks. One way of measuring this is to look at the number of autobiographical or personal memories that are generated in response to an artwork. Evidence of these memories demonstrate that the participant is connecting on a personal level with an artwork. In this study, the majority of participants in both groups reported that autobiographical memories were evoked in response to the photos, supporting previous findings (Hutchinson and Eardley 2021). While this suggests that the experience of listening to AD did not hamper a personal response, indeed, it may have enhanced it, EDG did not appear to offer any advantages over ADG when it came to evoking those memories. It is possible that the sounds within the EDG did not enhance memory recall further because the photo content and the audio described commentary were already very successful at evoking memories, with 82% of the sample recording memories.

The generation of autobiographical memories across both groups of participants provides a relevant and important finding, as it suggests the audio interpretation enables participants to engage with the photos, reflect on possible meanings, and relate this to their own experiences. This is consistent with the importance of personal context and meaning-making, and its relationship to identity, as discussed in the museum research literature (Dierking and Falk 1992; Falk 2006, 2013; Paris and Mercer 2011). Paris and Mercer (2011) suggest that visitors seek common ground with their own personal lives when exploring museums. The presence of autobiographical memories in this study, in response to both ADG and EDG, suggests the potential for inclusive audio interpretation to facilitate this.

In addition to considering personal memories that are evoked in response to artworks, it is also important to look at the impact of audio interpretation on the memorability of the artworks that are being experienced. Crucially, this study demonstrated that EDG provided enhanced access for BPB in terms of memorability. BPB participants recalled more photos with EDG. This was not the case for the sighted group. There was no difference between the BPB and sighted groups in terms of the number of photos recalled with EDG. Furthermore, the EDG memories were equally rich with detail in both participant groups. There are multiple possible explanations for the enhanced memorability of EDG photos for BPB participants. It is possible that the presence of sounds was able to increase interest and emotion, both of which can lead to enhanced recall (Holland and Kensinger 2010; Renninger and Hidi 2015). The additional layer of perceptual experience that the sounds provided may also have enhanced the generation of mental images. This was supported by the qualitative analysis of the BPB participants' thoughts on the experience and the sounds, which indicated increased imaginative engagement. Nevertheless, these explanations are of course not mutually exclusive.

We had expected the EDG to enhance memorability in the sighted group also, but this was not observed here. It is possible that the 'guided looking' (Hutchinson and Eardley 2021) provided by the AD experience, in conjunction with accessing the photos visually, provided ample input for the sighted participants to form sufficient connections at encoding. The effect of any additional perceptual experience may simply be superfluous. Further research could explore whether this difference would be replicated in future studies.

If there is a tendency for BPB participants to recall fewer memories than sighted participants (Tekcan et al. 2015), then the use of EDG may negate this tendency. It may simply provide nonvisual cues, which have been shown to result in equivalent memories across congenitally totally blind and sighted participants (Eardley and Pring 2006).

We recognise that the potential impact from methodological differences cannot be entirely eliminated. Whereas the sighted participants typed their answers into an online questionnaire, 93% of BPB participants chose to dictate their responses to the researcher. It is therefore possible that BPB participants provided more information because it is easier and quicker to speak than to type. This could account for the larger number of autobiographical memories in BPB participants. However, if the difference between dictation and typing was systematically impacting the volume of responses given by the participants, then one could expect to observe this across the variables, but there were no differences in the richness of the photo recall memories.

Finally, it is important to recognise the heterogenous nature of the BPB participant group. Three participants were congenitally blind, others had access to a life-time of visual memory, following recent sight loss in older age. However, while the spectrum of visual experience was broad, all BPB participants had insufficient vision to access collections in a museum without using AD. The heterogeneity of the BPB group reflects the diverse nature of the BPB museum audience, but it also possible that the heterogeneity makes it harder to find an effect of EDG. Had the study focused on participants with very little vision or visual experience, then the effects may have been stronger than reported here. Museums should therefore consider that the memorability benefits found in this study could be of even greater importance when considering the museum access needs of people with very little vision or visual experience.

These findings suggest exciting creative opportunities for museums who wish to offer inclusive interpretation to their visitors, and thereby facilitate more shared experiences. This study provides further evidence to support the notion that AD facilitated experiences can be enjoyed and provide benefit to BPB and sighted people alike. Crucially, further enrichment of AD with congruent sound can enhance interest and enjoyment for all visitors, and create more memorable experiences for blind people. These results indicate that offering AD that is enriched with congruent sounds would be a valid and valuable choice for museums to offer to their visitors. In so doing, they would increase their access provision and simultaneously enhance their interpretation for many users beyond the access audience.

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