Memoir: Quantifying Image Memorability in Adolescents

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Introduction

- Image memorability can be defined as “the probability that an observer will detect a repetition of a photograph at various delays after exposition, when presented amidst a stream of images“
- While memory itself is a process that occurs in the brain of an individual, the concept of memorability is an intrinsic, continuous property of a stimulus that can be both measured and manipulated
- In 2011, Isola, Xiao, et al. (2011) introduced their large-scale visual memory game used to test and quantify the memorability of images - a repeat decision task that allows for the calculation of image-specific memorability scores simply as the percentage of correct detections by participants
- Memorability ranks have been found to be time-independent (Khosla et al., 2015), meaning if time between showings were to be increased, the memorability scores of all images would decrease by a consistent amount, so rank ordering will be preserved
- Certain image features can be extracted and linked to memorability, such as: image category, saliency, contrast, and positive emotions
- Features that have been found to have weak correlations with memorability include colours/colour features, perceived estimates of memorability, semantic attributes, and negative emotions
- While extensive work has been done to study image memorability in adults, no studies exist regarding the adolescent (ages 11-18) population and the differences in image memorability across different age groups
- Specifically in adolescents, the ability to maximize visual memorability has profound implications for education, particularly in youth with certain developmental and educational disabilities
- This study aims to fill this gap by assigning memorability scores derived from adolescents to images and comparing them to memorability scores derived from adults

Methods

Stimuli

The stimuli in this study were selected from MemCat, a recently published image memorability dataset. The MemCat dataset is publicly available and includes 10,000 images that have been annotated with adult memorability scores. We used adult memorability scores provided by MemCat as a point of comparison to the adolescent memorability score we obtained in this study. For our adolescent dataset, which we call the Memoir dataset, we randomly sampled 1,000 images from the MemCat dataset equally from each category and from the full range of memorability scores provided in MemCat.

Experiment Design

To measure image memorability, we conducted an online visual memory game and recruited participants through Amazon Mechanical Turk (see schematic in Figure 1). Participants were shown a sequence of images, each displayed for 600 ms with 800 ms inter-stimulus intervals, and were instructed to press the spacebar when they encountered an image that they remembered being shown previously. The inter-stimulus intervals consisted of a blank white screen with a black fixation cross and were shown for 800 ms. Target images were repeated exactly one time and at variable time intervals (after 19-149 filler images). The filler images comprised everything in between the targets and were only displayed once, with occasional vigilance repeats of fillers being shown to ensure participants were alert. Vigilance repeats were used to ensure that the participants were paying attention and participating meaningfully, and were repeated after 0 to 2 images.

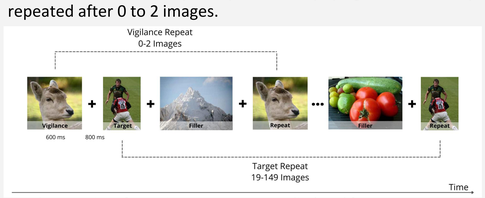

Fig. 1. Design of experiment: images were displayed for 600 ms followed by an 800 ms blank screen with a fixation cross. Participants were instructed to press the spacebar when they recognized a second occurrence of any image.

Computing Memorability Scores

Following MemCat, we computed two different memorability scores for each image:

$$\frac{H}{Nresp} \quad (1)$$

$$\frac{H-F}{Nresp} \quad (2)$$

Results

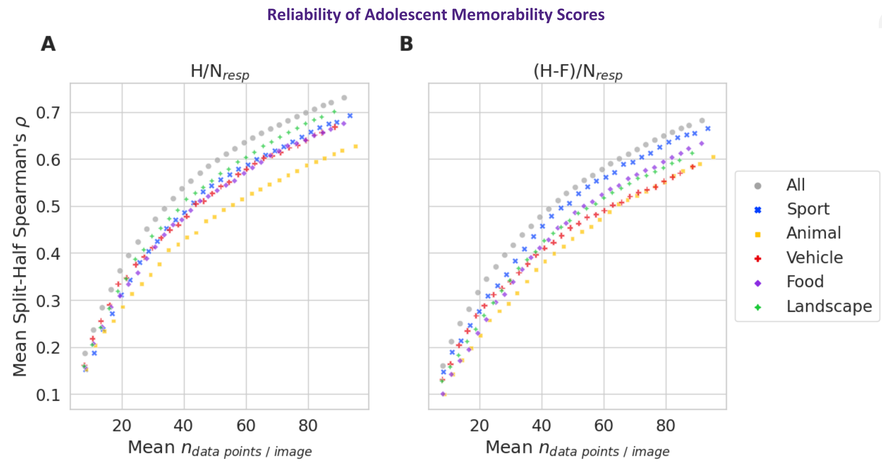

Fig. 2. Split-half consistency across participants of the (H − F)/Nresp memorability scores as a function of Nresp. Estimates are based on 25 random splits. Nresp refers to the sum of data points per image, not the number of data points in one half during the split-half procedure.

We measured the consistency and reliability of the computed memorability scores by splitting the participants into two independent sets, computing their respective memorability scores separately for each set, and calculating the Spearman’s rank correlation between the two sets. Generally, the rank correlations were higher in the H/Nresp scores. Using all available data points and across all categories, the mean split-half rank correlation using this measure was 0.73 (with a mean Nresp of 94). This is comparable to MemCat, who reported an overall reliability of 0.78 (with a mean Nresp of 99). The strength of these correlations indicates the reliability of measured memorability scores across adolescents population, in spite of individual differences and other sources of noise.

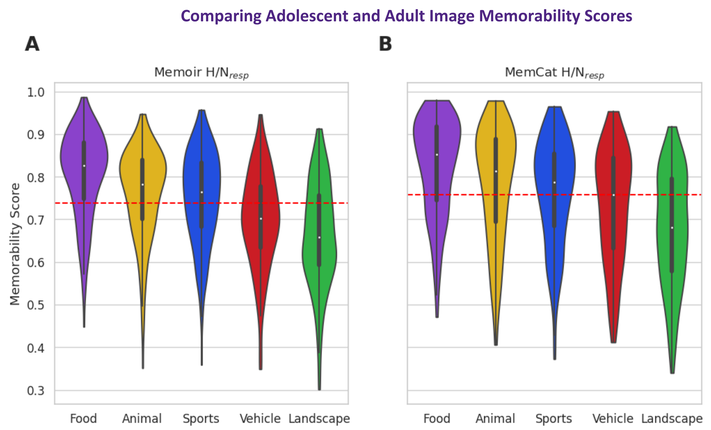

Fig. 3. Distribution of collected memorability scores in adolescents (A) and adults (B). Adult data is from the MemCat dataset (Goetschalckx & Wagemans, 2019). The red horizontal line is the global mean memorability score for each of the populations (M = 0.74 and M = 0.76 for adolescents and adults, respectively). n = 1, 000 for both figures.

Mean memorability scores in adolescents (M = 0.74, SD = 0.12) were comparable to mean memorability scores in adults (M = 0.76, SD = 0.14). As well, the Spearman’s rank correlation coefficient between the adolescent and adult data was very high (ρ = 0.76, p < 0.001) and close to the reliability correlation we established in the previous section. The category rankings are also identical in adolescents and adults. In both age groups, the food category is the most memorable, followed by animal, sports, vehicle, and landscape.

Discussions and Conclusions

- Our findings support previous research that suggests memorability is an intrinsic property of images that is consistent across viewers
- Memorability rankings were consistent across adolescents and adults, indicating that viewer age is not a factor in determining the memorability of images. This is consistent with previous findings that show memorability is intrinsic to the image, rather than the observer
- In addition to individual image rankings, category rankings are also consistent across adolescents and adults. Food images are the most memorable, while landscape images are the least memorable.
- While the rankings of image memorabilities was similar in adolescents and adults, adolescents experienced significantly higher false alarm rates. Adolescence is widely recognized as a developmental period during which risk-taking and reward-seeking actions are increased. By the time they reach adulthood, adolescents’ risk-taking declines due to structural and functional changes in the brain’s cognitive control system. The increased cognitive control that comes with the maturation of the brain may explain the higher false alarm rates we observed in adolescents. Their increased impulsivity and need for immediate rewards combined with the rapid nature of the visual memory game caused adolescents to be less patient/cautious with their button presses than adults
- Despite this, we find that for both adolescents and adults the same images are likely to fall into the “truly memorable" category. Taken together with the high rank correlation between the adolescent and adult memorability scores, we can conclude that memorability is highly consistent and reliable across these two age groups
- Previous work (Bainbridge et al., 2013) has suggested that images with a high hit rate yet a low false alarm rate are “truly memorable", while those that receive both a high hit rate and a high false alarm rate may simply conjure strong false memories. We aimed to determine whether similar images in adolescents and adults were truly memorable. To isolate these truly memorable images, we divided the images into four quadrants consisting of high/low hit rates (HR = H/Nresp) and false alarm rates (FAR = F/Nresp).
- False alarm rates, in general, were significantly higher in adolescents (M = 0.13, SD = 0.066) than in adults (M = 0.057, SD = 0.051); t(1, 000) = −42.81, p < 0.001.
- However, the Spearman’s rank correlation between false alarm rates in adolescents and adults was moderately high (ρ = 0.55, p < 0.001).
- Therefore, memorability is more consistent across participants than familiarity. Applying the correction was effective in reducing the noise in the truly memorable images, but reduced our overall rank correlation and reliability
- The ability to measure and manipulate memorability has profound applications in many fields, such as education, marketing, and psychology. Specifically in adolescents, educators can make use of this insight to create educational material (for example, images in textbooks) that is more likely to be remembered. For example, learning examples making use of food images will be more optimal than those that make use of vehicle images, as students are more likely to remember them visually. Developmental Coordination Disorder (DCD) and Attention Deficit and Hyperactivity Disorder (ADHD) are two of the most common neuro-developmental disorders in school-aged adolescents, with CDC and ADHD global prevalences estimated at 6% and 9.5%, respectively (Delgado-Lobete, Pértega-Díaz, Santos-del Riego, & Montes-Montes, 2020). There is evidence that individuals with these conditions exhibit impairments in multiple components of working memory (Martinussen, Hayden, Hogg-Johnson, & Tannock, 2005); therefore, optimizing learning material could greatly improve knowledge retention in these students to aid their learning. Other applications include optimizing the memorability of advertisements, movies, and other forms of media targeted at adolescents

References

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