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Adult Age Differences in Noninstrumental Information-Seeking Strategies

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We often seek information without any explicit incentives or goals (i.e., noninstrumental information seeking, often noted as a manifestation of curiosity). Does noninstrumental information-seeking change with age? We tried to answer the question by making a critical distinction between two information-seeking behaviors: *diversive information seeking* (i.e., information seeking for topics a person knows little about) and *specific information seeking* (i.e., information seeking to deepen a person's existing knowledge of a topic). Five hundred participants (age range: 12–79 years old) spontaneously read new facts about different topics. After reading each fact, participants were given the choice to read more facts about the current topic or return to the selection menu to learn about a new topic. We found that with increasing age, participants chose to explore more facts within a topic (i.e., increased specific information seeking) and switched less frequently to new topics (i.e., decreased diversive information seeking). These results indicate that while young people seek out a broader range of information, as people grow older, they develop a preference to deepen their existing knowledge.

Public Significance Statement

The present study demonstrates that information-seeking tendencies can shift with age: younger adults prefer to consume a broader variety of information, while, with increasing age, people focus on deepening their knowledge of a given topic. This has implications for how new information should be communicated to different age groups in order to best support intrinsically motivated learning. This consideration of age differences in patterns of information consumption has a vast range of potential applications, from educational curriculum and course design to museum exhibit layouts to the provision of health information.

Keywords: information seeking, curiosity, adult development, intrinsic motivation, learning from text

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We routinely search for information in our daily lives (e.g., read an article). In recent years, several studies have shown that people have an intrinsic motivation to seek information even if it does not have any immediate benefit (e.g., Baranes et al., 2015; Charpentier et al., 2018; van Lieshout et al., 2019). Such search is called noninstrumental information seeking and is often assumed to be a manifestation of curiosity and/or interest. Despite the prevalence of information-seeking behavior in our daily lives, and despite its potential importance in healthy aging (Sakaki et al., 2018), there have been a limited number of empirical studies examining how it changes across the adult lifespan. Previous research has found that aging is associated with declines in information seeking in general (see Mata & Nunes, 2010, for a meta-analysis) as well as subjective feelings of curiosity (for a review, see Sakaki et al., 2018).

However, previous studies have overlooked the possibility that with increasing age, people shift to a different style of information seeking (Donnellan et al., 2022; Murayama, 2022). In life, the mass of information we confront forms a complex network, and information is often consumed without knowledge of how it will be used in the future (e.g., for making judgments or decisions). In these instances, information typically forms a hierarchical structure whereby information can be categorized by different topics. Here, people might differ in their approach to exploring this network of information. One aspect of information seeking on which people might differ is the degree to which they aim to (a) deepen knowledge of a specific topic or (b) broaden their knowledge of topics about which less is known.

The distinction between wider and more narrow information seeking was first introduced by Berlyne (1960), who distinguished between specific and diversive information-seeking behavior. According to Berlyne, specific information seeking focuses on the acquisition of a specific piece of information, while diversive information seeking focuses on broader exploration. Berlyne considered the two types of information seeking as fundamentally different processes that are triggered by different psychological mechanisms and biological needs (Berlyne, 1966). In particular, Berlyne saw specific exploration as information seeking "aimed at stimuli coming from one particular source, providing information about one particular object or event" (Berlyne, 1960, p. 80) and diversive exploration as exploration "that has no … direction" (Berlyne, 1960, p. 80) but is for the purpose of acquiring new experience or combatting boredom. He also stated that diversive information seeking is "motivated by factors quite different from curiosity" (Berlyne, 1966, p. 27).

Litman and Spielberger (2003), however, found in their questionnaire-based research that individuals' tendencies to engage in specific and diversive information-seeking behavior were positively related to each other; these results, therefore, suggest that specific and diversive information-seeking tendencies are related and could be seen as different facets of curiosity. In a more recent study, Lydon-Staley et al. (2021) had participants browse text-based information on https://Wikipedia.org and recorded the topics they chose to read. Following the distinction by Litman and Spielberger (2003), they identified two groups of people: hunter-style information gatherers who tended to seek out related themes before making bigger jumps (akin to specific information seeking), and busybody-style information gatherers who tended to make frequent broader jumps between topics without looking for deeper information (akin to diversive information seeking).

The distinction between specific information seeking aimed at deepening one's knowledge and diversive information seeking aimed at broadening one's knowledge is particularly important in the context of adult development. During specific information seeking, people update an already existing mental representation of a topic. This way of integrating information relies more heavily on prior knowledge; in other words, specific information seeking is more dependent on prior knowledge. Older people generally possess more knowledge across different domains (Beier & Ackerman, 2005). Previous research has also shown that knowledge does not only increase quantitatively with age—aging also qualitatively enriches the way both verbal and semantic networks are organized (Wulff et al., 2019). Therefore, adults should engage in specific information seeking more frequently with increasing age. In contrast, diversive information seeking allows people to broaden the scope of knowledge, providing the basis for understanding various new incoming information. Because younger people are likely to lack the breadth of knowledge that older adults already acquired, they should have a general preference for engaging in diversive information seeking.

The present study aimed to examine the possibility that people engage in more specific information seeking as opposed to diversive information seeking as they grow older. Similar ideas have already been examined in the literature. For example, using classical foraging tasks, researchers showed that older adults tend to stick to the old locations (referred to as "patches" in the foraging literature) more frequently than moving to new locations compared with younger adults (for a review, see Spreng & Turner, 2021). Mata et al. (2013), for instance, used a paradigm analogous to a foraging problem. Participants were told to catch fish or solve word puzzles in different locations (patches). Patches were of variable quality, with some having more fish or correct solutions than others. With growing success, the patches would be exhausted. The results showed that older adults waited longer to move to the next patch than younger adults and such age-related change has been theorized to be related to increased prior knowledge of older adults (Spreng & Turner, 2021). These tasks, however, are driven by a specific goal to maximize an outcome (e.g., rewards/correct solutions). Therefore, it is possible that the results reflect age-related differences in goal-driven strategic decision-making behavior rather than voluntary information-seeking styles.

To our knowledge, there are only two other studies that compared younger and older adults' behavior in an information-seeking task. In the first study, Chin et al. (2015) showed that older adults used fewer keywords to examine a topic in an online information search task and spent more time on each website before changing keywords. These results are consistent with the idea that older adults prefer specific information seeking. In the second study, Liu et al. (2016) gave participants facts with varying amounts of elaboration and complexity to learn about a topic; while all age groups gradually changed their selections from less to more complex facts, in comparison to younger adults, older adults showed a preference for items with less elaboration and complexity. As the depth of elaboration and the complexity of sentences were confounded in the study, it is not possible to draw any conclusions about specific information-seeking tendencies within the study. In addition, participants in both studies were told that their memory of the learned materials would be tested. This means that search behavior in these tasks still likely reflects the strategic decision making of participants rather than their voluntary information-seeking style.

To examine age-related changes in the two different styles of noninstrumental information seeking (i.e., specific and diversive information seeking), we developed a novel text-based paradigm in which participants could freely explore information with no explicit instrumental value (see Fastrich & Murayama, 2020). Participants were allowed to explore information within a specific topic to learn more about it or switch to a different topic to diversify their knowledge. This design enabled us to examine whether increasing age has similar or different impacts on specific and diversive information seeking. We expected that specific information seeking increases and diversive information seeking decreases as people grow older.

Method

Transparency and Openness

Materials, anonymized data, and analysis code are accessible online (see Author's note). Neither the study design, hypotheses, nor the analytical plan of the study were preregistered. We report how we determined our sample size and describe all data exclusions, manipulations, and all measures in the study.[1]

Participants

Participants comprised 498 visitors (M_{age} = 28.91, SD = 13.08, age range = 12–79) to the London Science Museum in 2018 from July to August. Visitors were supervised during their participation in the experiment, and written consent was obtained from the participants before the start of the data collection. All procedures were approved by the University of Reading (University of Reading Ethics Committee 18/10—Title: "Understanding Curiosity") prior to data collection. Data collection was stopped when our exhibition at the London Science Museum ended. About 274 identified as "female," 206 as "male," 5 described their gender differently, and 13 did not state their gender. Approximately two thirds of participants (N = 354) reported to be English native speakers. Data were collected from an additional 81 individuals whose data were excluded (see Data Analysis section for details).

Of the 498 participants, 96 were younger than 18 years old. Since they were likely still in compulsory education, we did not ask them about the highest level of education. The remaining participants (n = 402) were asked to indicate their highest level of education among "Some secondary education (n = 9)," "GCSE (*General Certificate of Secondary Education; N* = 21)," "A-levels (*Advanced Level Qualifications*)/GCEs (*General Certificate of Education; n* = 104)," "University graduate (n = 149)," and "Postgraduate qualification (n = 110)." Eight participants did not report the highest level of education. Education data from one participant is missing. About 39 participants reported to be "Asian or Asian British," 14 to be "Black, Black British, Caribbean or African," four reported to be "Chinese," 396 to be "White," and 33 to be "Mixed or Other" ethnicity. About 12 participants did not report their ethnicity, and ethnicity data were missing from one participant. Ethnicity and the highest levels of education within different age groups are reported in the Supplemental Materials. The Supplemental Table S1 includes a description of demographic variables split by age group.

To determine the level of power achieved by this sample size, we conducted a sensitivity analysis with N = 498; our focus is on individual differences (i.e., age). The analysis showed that the sample size is sufficient to detect a small effect size of age (i.e., r = 0.12) at the power of 80% (two-sided, α = .05).

Table 1 shows an overview of means and standard deviations for important variables split by age groups. For the purpose of summarizing the descriptive statistics, age groups were split into decades with the exception of the youngest and oldest age groups (12–18 and 61–78). The youngest participants were split to differentiate between school-age and college-age participants, and the oldest group was combined due to the small number of participants. Due to a technical error, only 402 participants provided ratings of prior knowledge. On average, the highest rating of prior knowledge that each participant reported was 1.40 (SD = 1.71), and on average, participants reported a prior knowledge of 0.53 (SD = 0.74) for each topic. This shows that people were very likely to learn new information and started learning about a topic with very little prior knowledge about it.

Stimuli

Stimuli were brief facts (4–78 words long) from five main themes ("Mythical beasts," "Lesser known countries," "Lesser known scientists," "Historical expeditions," and "Prehistoric animals"). Each theme included eight different *topics* not widely known by the public (e.g., "Glyptodon" as a topic of *Prehistoric animal* or "The Darian Scheme" as a topic of a *Historical expedition*). For each topic, there were 10 relevant *facts* (e.g., "Glyptodons lived in both North and South America."). The facts were collected from the internet (e.g., https://wikipedia.org) and written in a manner that was easy to understand for naïve readers (i.e., the facts were understandable regardless of prior knowledge about the topic; see Supplemental Table S2 for an example). Lesser known topics and facts were selected to ensure that participants had little prior knowledge based on the judgment of the researcher team.

Procedure

The study was conducted in a section of the London Science Museum dedicated to citizen science projects in a busy part of the museum floor. There were three computers for participants to complete the experiment. The area was partially screened from the rest of the museum. Participants passing by or interested in the booth were explained its purpose and invited to take part. Participants were told that they could spend as much time as they wanted on the experiment and were free to leave at any time. Participants were not compensated for their time.

At the beginning of the task, participants were asked to select the theme they were most interested in; once selected, this could not be

[1] The experiment was part of a series of independent experiments centered around information seeking behavior that participants were able to take part in. Participants could freely choose which experiments they wished to do and what order to do them in. The other experiments were not related to the one reported in this article.

Table 1
Participant Characteristics and Descriptive Statistics

Age group	n[a]	Undergraduate degree[b]	Total facts		Total topics		Average curiosity		Average interest		Prior knowledge		Known facts	
			M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
12–17	96	Not available	9.40	9.08	4.00	2.40	4.18	1.14	3.98	1.19	0.40	0.61	0.11	0.19
18–20	64	20.31%	9.50	13.45	3.23	2.20	3.86	1.25	3.92	1.22	0.60	0.87	0.12	0.19
21–30	149	68.24%	11.80	10.58	3.96	2.20	4.02	1.15	3.87	1.10	0.52	0.72	0.12	0.18
31–40	84	77.39%	10.10	11.28	3.51	2.23	4.05	1.22	3.80	1.35	0.43	0.72	0.11	0.16
41–50	76	80.62%	11.70	13.85	3.43	2.11	4.16	1.27	4.13	1.27	0.60	0.73	0.11	0.16
51–60	19	57.90%	18.79	24.51	3.53	2.12	4.63	1.08	4.78	0.95	0.93	0.76	0.12	0.18
61–78	10	80.00%	16.80	13.58	3.10	2.13	4.23	1.32	4.51	1.28	0.91	1.17	0.29	0.27

[a] Number of participants for the whole data set; note that not all participants have prior knowledge ratings. [b] Percentage of participants who stated that they hold an undergraduate degree or higher.

changed throughout the experiment. Next, participants were presented with a list of eight topics belonging to the theme and asked to rate their prior knowledge about a topic on a 7-point Likert scale from "0 = *nothing at all*" to "6 = *everything there is to know*." After the rating, participants were asked to choose one of the eight topics to learn facts; a list of the eight topics was shown along with a button labeled "End Task," which allowed participants to exit the task at any time. Topics were presented in a random order in the outer cells of a three-by-three table (see Figure 1a).

Once participants selected a topic, they left the overview and were presented with a graphic relating to the topic. Underneath the picture, the information and questions relating to the fact were presented (see Figure 1b). First, participants received a teaser about the upcoming fact ("Now you will learn about Glyptodon's size.") and then rated their feelings of curiosity about the upcoming fact on a 7-point Likert scale from "0 = *not at all curious*" to "6 = *very curious*." After the feelings of curiosity rating, participants were presented with the main text describing the fact, followed by a question of whether they already knew the fact or not. Finally, they were asked to rate how interesting they found the fact on a 7-point Likert scale from "0 = *not at all interesting*" to "6 = *very interesting*." Note that our main dependent variable was the choice of topics participants decided to learn (see below) rather than curiosity and interest ratings. However, we also analyzed these data on subjective feelings for exploratory purposes.

After the interest rating, participants chose if they wanted to read another fact about the same topic, read information about another fact from a different topic, or finish the experiment. Figure 1 depicts a trial overview. Facts for a topic were presented in a random order. All steps were self-paced. Participants were allowed to stay on the same topic until they had read all 10 facts, but they could also switch to a new topic at any point and were allowed to revisit the topic later. With this task design, participants could read between 1 and 80 facts from one to eight topics. The final data set includes only data from participants who read at least two facts overall (see the Participants section).

Data Analysis

Data from 75 participants were excluded because they terminated the task after reading just one piece of information. This is because we were concerned that these participants were not sufficiently engaged in the task. Their data also could not contribute to our understanding of specific or diversive information seeking since this relies on a choice to either stay within a topic or move between topics—terminating the task after reading one fact reflects neither.

To ensure that participants paid attention to the task, average reading times were checked. Average reading times for each participant ranged between 2,802 and 31,337 ms, a range that likely reflects the differing word counts for each fact (4–78 words) and differences in individuals' reading speed, as well as distractions that may have been present during the task. As facts of different lengths should result in different reading times, we first adjusted each participant's reading time based on the facts they had read. This was done by calculating the average reading time for each fact across participants. This average fact reading time was then subtracted from each individual reading time of that fact. Average reading times for all facts for each participant were then calculated using this adjusted reading time. Six participants whose adjusted average reading times were above 3 *SD*s of the mean of the adjusted average reading times were excluded from the data.

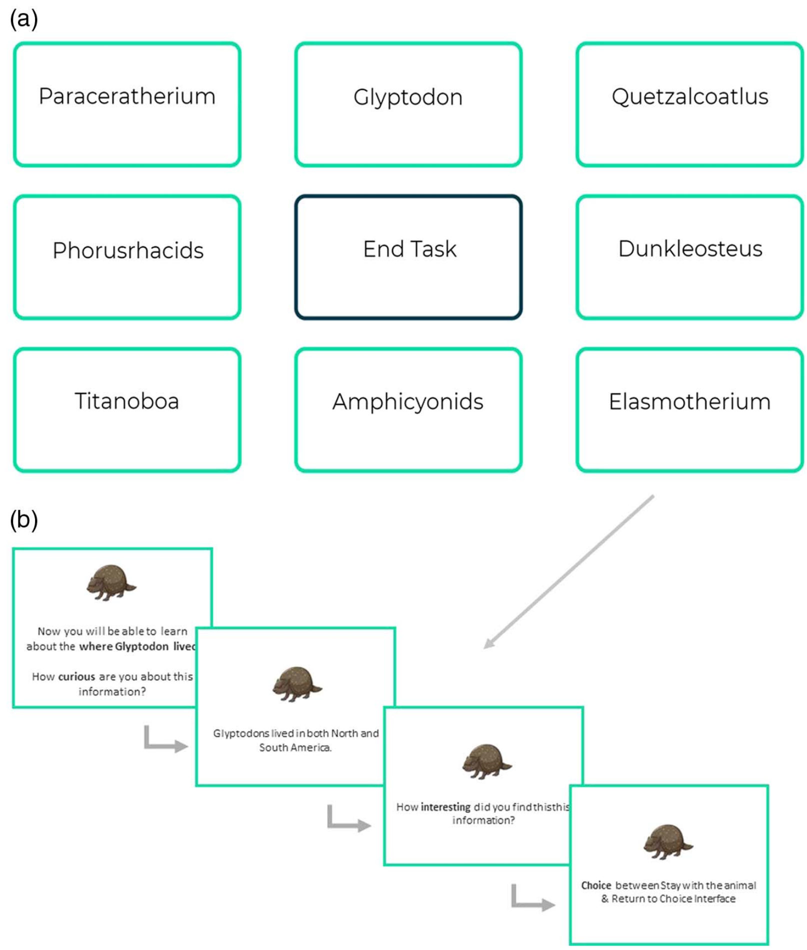
All analyses were conducted in R (R Core Team, 2020). The *survival* package (Therneau, 2020) was used for the survival analyses, *lme4* (Bates et al., 2015) and *lmerTest* (Kuznetsova et al., 2017) were used to perform linear mixed-effects models and graphs were generated with *survminer* (Kassambara et al., 2021) and *ggplot2* (Wickham, 2016).

We performed two multivariable Cox regression analyses to test the effects of age on specific and diversive information seeking (Therneau & Grambsch, 2000). Survival analysis was a natural choice in light of the nature of the task: At every time, participants had a binary state of continuing (i.e., survive) or terminating (i.e., death) information seeking. In addition, survival analysis has merit in that it can differentiate between cases in which participants chose to stop exploring facts or topics and those in which participants were forced to stop because they had reached the last fact or topic.

To examine "specific information seeking," the first survival analysis examined when participants stopped reading facts within a topic (this was treated as the "death" event in survival analysis terminology). For example, if a participant switched to a different topic after reading the third fact, the death event was deemed to have happened at $T = 3$ for this topic. As topics are nested within participants, we used a hierarchical model to account for data dependency.

To examine "diversive information seeking," the second survival analysis examined how many topics participants explored

Figure 1
Layout of the Selection Menu (a) and an Example Trial (b)



Note. The picture used in the example trial is demonstrative and was not used in the actual experiment. Picture is free to use as the license for the picture was paid for by the authors. The picture can be found at https://www.freepik.com/free-vector/glyptodon-extinct-mammal-vector_36362571.htm. See the online article for the color version of this figure.

before ending the task. For example, if a participant ended the task after looking at the facts of fourth topic, the death event was deemed to have happened at $T = 4$. In this analysis, the unit of analysis was participants; and therefore, we did not apply a hierarchical model.

For both analyses, age (as a continuous variable) was included as the main predictor. Additionally, gender, first language (whether English was the first language or not), and the total number of facts a person has read ("total facts read"; see our correlation analysis) served as control variables. The hazard ratio (HR) is the natural logarithm of the parameter estimate, which describes how much a covariate reduces (HR $<$ 1) or increases (HR$>$ 1) the risk of death (here: disengagement) for each unit the covariate increases. Further analyses included age binned into categories to examine the nonlinear effects of age.

While we believe that survival analysis is the natural choice to test our prediction, we also repeated the analyses with mixed-effects modeling in order to examine the robustness of our findings across analytic methods (see Supplemental Materials).

Lastly, we explored the potential nonlinear effects of age by examining descriptive statistics for different age groups and replicating the survival analyses with the different age groups as a predictor. We also report an exploratory analysis of self-reported feelings of interest and curiosity on disengagement as well as an exploratory analysis of switch costs.

Results

Overview of Content Selection

The most frequently chosen theme was "Mythical beasts" (N = 161; M_{age} = 26.05, SD_{age} = 10.86), while the least popular theme was "Historical expeditions" (N = 64; M_{age} = 33.83, SD_{age} = 16.48). "Lesser explored countries" was chosen 128 times (M_{age} = 31.47, SD_{age} = 13.63), "lesser known scientists" was chosen 75 times (M_{age} = 28.32, SD_{age} = 12.91), and "prehistoric animals" was chosen 70 times (M_{age} = 26.91, SD_{age} = 11.52). There was a significant difference in age between the participants who selected the different themes, $F(4, 493) = 6.09$, $p < .001$, but no significant difference in the number of total facts participants looked at, $F(4, 493) = 1.60$, $p = .172$, across themes. On average, participants read a total of 11.10 facts ($SD = 12.31$) from an average of 3.68 topics ($SD = 2.23$). Within each topic, participants read, on average, 2.93 ($SD = 2.10$) facts.

There were only 63 occasions in which participants revisited a previous topic they had left. The return to a previous topic was considered as reading an additional fact from that topic during further data analysis. On average, the 50 participants who returned to a previous topic were 26.54 ($SD = 13.34$) years of age, while participants who did not return to a previous topic were, on average, 29.17 ($SD = 13.04$) years old. This difference was not significant, $t(59.94) = 1.32$, $p = .190$. Participants reported that they knew 12% of the facts on average ($SD = 18\%$). All the *SD*s reported here were computed based on between-person differences.

Relationships Between Core Variables

All correlations between core variables are reported in Table 2. Older participants read a larger number of facts in total (irrespective of topics; a "total facts read" measure), $r(498) = .138$, $p = .002$. Older adults were also more likely to read a larger number of facts for each topic (an "average facts per topic" measure), $r(498) = .254$, $p < .001$. However, older age was not correlated with the number of topics looked at (a "total topics" measure), $r(498) = -.067$, $p = .133$.

Importantly, the total facts read measure was highly correlated both with the total facts read per topic measure, $r(498) = .692$, $p < .001$ and the total topics read measure, $r(498) = .632$, $p < .001$ (it reflects the combination of the two). These results suggest that the total facts read was (logically) strongly related to the two information-seeking styles: (a) one which prioritizes a targeted consumption within a topic (i.e., "specific information seeking," reflected by the total facts read per topic measure), and (b) the other which prioritizes looking at a wider range of topics with relatively few facts for each topic (i.e., "diversive information seeking," reflected by the total topics read measure). Therefore, in the following main analyses, we included the total facts read as a critical controlling variable. The number of facts participants already knew did not significantly correlate with age, $r(498) = .032$, $p = .474$, nor did it correlate with total facts, $r(498) = .035$, $p = .430$, or total topics, $r(498) = -.017$, $p = .707$.

The average self-reported feelings of curiosity were significantly correlated with total topics and average facts per topic (see Table 2), $rs\ (498) = .105, .212$, $p_{totaltopics} = .022$, $p_{averagefacts} < .001$, and average self-reported feelings of interest were significantly correlated with average facts per topic, $r(498) = .211$, $p < .001$. The average level of self-reported curiosity did not significantly correlate with age, $r(498) = .051$, $p = .257$. In contrast, the average of self-reported interest showed a significant weak positive correlation with age, $r(498) = .096$, $p = .032$.

Average ratings of prior knowledge were positively correlated with age, $r(402) = .104$, $p = .038$, but not significantly correlated with total number of facts nor with total topics, $rs\ (402) = .078, -.075$, $ps = .117$ and $.134$.

Investigation of Different Information-Seeking Styles

As can be seen in Table 1, the average number of facts participants read within a topic, by and large, increased with growing age, while the number of total topics generally decreased, conforming with the findings reported above. However, these numbers are strongly related to the total number of facts participants read and must be considered while accounting for the total number of facts read.

To see the pattern after accounting for the total number of facts, we calculated the residuals from a simple regression/multilevel regression model of total facts read on either the average number of facts read within a topic or the total number of topics explored. The average residuals are depicted in Figure 2. As can be seen, except for the 18- to 20-year-olds, there is a continuous and monotonic trend that, with growing age, participants shift from diversive information seeking to specific information seeking. To provide a more nuanced statistical approach, we conducted survival analyses for both specific and diversive information seeking, in which we treated age as continuous and linear.

Specific Information Seeking

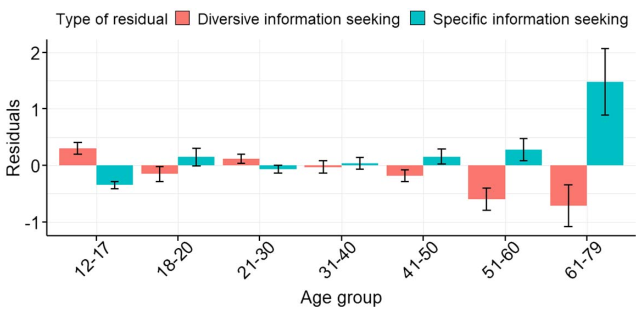
Table 3 displays the results of the survival analyses for specific and diversive information seeking. The hierarchical survival analysis found an HR of 0.987, 95% [CI [0.982, 0.992]; $p < .001$). This meant that the probability of an individual 1 year older ceasing exploration of new facts within a topic was 0.987 times the probability of a younger individual. Figure 3a shows survival plots by different age groups. Unsurprisingly, among control variables, total facts read was strongly positively associated with how many facts a person read within each topic (HR = 0.945, 95% [CI: 0.940, 0.951]; $p < .001$). Neither gender (HR = 1.031 95%, [CI: 0.969, 1.097]; $p = .342$) nor being a native English speaker (HR = 0.959, 95% [CI: 0.843, 1.092]; $p = .529$) showed a significant effect on specific information seeking. These results were replicated with a mixed-effects model (see Supplemental Materials).

Table 2
Between-Person Correlations

Variable	*n*	*M*	*SD*	1	2	3	4	5	6	7
1. Age	498	28.91	13.08	—						
2. Total facts	498	11.10	12.31	.138**	—					
3. Total topics	498	3.68	2.23	−.067	.632***	—				
4. Average curiosity	498	4.08	1.20	.051	.213***	.104*	—			
5. Average interest	498	3.97	1.22	.096*	.211***	.055	.780***	—		
6. Prior knowledge	402	0.53	0.74	.104*	.078	−.075	.119*	.067	—	
7. Known	498	0.12	0.18	.032	.035	−.017	.080	.011	.439***	—

* $p < .05$. ** $p < .01$. *** $p < .001$.

Figure 2
Residuals of the Regressions of Total Facts on Average Facts per Topic (Specific Information Seeking) and Total Topics (Diversive Information Seeking) With Standard Errors



Note. See the online article for the color version of this figure.

Diversive Information Seeking

In contrast to specific information seeking, diversive information seeking was negatively related to age; younger participants seemed to look at more topics. Here, with every increase in a year of age, the probability of stopping the exploration of new topics was 1.013 times the probability of a younger individual (HR = 1.013, 95% [CI: 1.006, 1.021]; $p < .001$). Figure 3b displays survival plots for each age group. Among the control variables, again, total facts read had a large relationship with how many topics participants explored (HR = 0.874, 95% [CI: 0.856, 0.893]; $p < .001$). Neither gender (HR = 1.028, 95% [CI: 0.932, 1.133]; $p = .586$) nor being a native English speaker (HR = 1.093, 95%, [CI: 0.885, 1.349]; $p = .410$) showed a significant effect. Again, these results were replicated with a mixed-effects model (see Supplemental Materials).

Robustness Checks

We repeated the specific- and diversive information-seeking analyses with the inclusion of different sets of covariates or variations of the data set to check the robustness of the results. These results are reported in the Supplemental Tables S3–S6. All analyses replicate the effect of age on diversive and specific information seeking. Of particular interest were two replications that included the average subjective feeling of curiosity and prior knowledge ratings (Supplemental Table S3). When the average subjective feeling of curiosity was added to the analysis, we found that average subjective feeling of curiosity predicted both diversive information seeking (HR = 1.088, [95% CI: 1.000, 1.184]; $p = .048$) and specific information seeking (HR = 0.765, 95% [CI: 0.718, 0.816]; $p < .001$) in that participants with a higher average subjective feeling of curiosity showed increased specific information seeking and decreased diversive information seeking. Prior knowledge ratings had a similar effect on specific and diversive information seeking (Specific information seeking: HR = 0.934, 95% [CI: 0.885, 0.986]; $p = .014$; diversive information seeking: HR = 1.248, 95% [CI: 1.078, 1.444]; $p = .003$).

As we detected significant age differences between the participants who selected different themes, we repeated our main analyses within each theme. These results are reported in the Supplemental Table S6. While only two out of the 10 analyses find a significant effect of age (likely due to reduced statistical power), seven of the eight remaining analyses show hazard ratios in the predicted direction. This indicates that the age effects are independent of the selected theme.

Potential Nonlinearity of Age Effect

Previous analyses supported our expectation that age is positively associated with specific information seeking, whereas it is negatively related to diversive information seeking. To examine potential nonlinear effects of age, we first repeated our main analyses with a quadratic term of age included and secondly, examined the pattern by binning participants according to their age. In both the specific and diversive information seeking analysis, the quadratic term of age was not significant (Specific information seeking: HR = 1.000, 95% [CI: 1.000, 1.000]; $p = .944$; diversive information seeking: HR = 1.000, 95% [CI: 1.000, 1.001]; $p = .280$), while the linear term of age remained significant (specific information seeking: HR = 0.987, 95% [CI: 0.981, 0.993]; $p < .001$; diversive information seeking: HR = 1.011, 95% [CI: 1.002, 1.020]; $p = .017$).

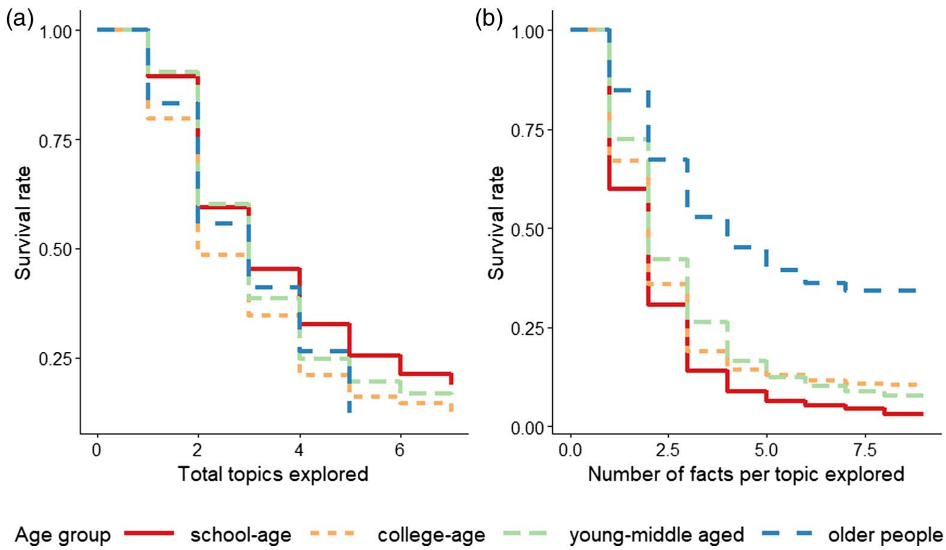
Additionally, we conducted survival analyses with the age groups added as a series of dummy coded variables (see Supplemental Table S7). Both specific and diversive survival analyses were conducted twice, either with 31-to 40-year-olds or 41-to 50-year-olds as a reference group, as these represent the midpoint of our distribution. Only some comparisons between the oldest and/or youngest group and the reference group became significant. The coefficients, however, show a gradual change across age groups, indicating that specific information seeking consistently increases and diversive information seeking consistently decreases as participants grow older. The results of these analyses are reported in full in the Supplemental Materials.

Table 3
Results of the Survival Analyses for Specific and Diversive Information Seeking

	Specific search				Diversive search			
Parameter	No.	HR	[95% CI]	*p*	No.	HR	95% CI	*p*
Age	1,707	0.987	[0.982, 0.992]	<.001	429	1.013	[1.006, 1.021]	<.001
Total facts read	1,707	0.945	[0.940, 0.951]	<.001	429	0.874	[0.856, 0.893]	<.001
Native language	1,707	0.959	[0.843, 1.092]	.529	429	1.093	[0.885, 1.349]	.410
Gender	1,707	1.031	[0.968, 1.097]	.342	429	1.028	[0.932, 1.133]	.586

Note. No. = number of events; HR = hazard ratio; CI = confidence interval.

Figure 3
Survival Rate During Exploration



Note. Survival rate during the exploration for school-aged (12–17, $N = 96$), college-aged (18–20, $N = 64$), young middle-aged (21–50, $N = 309$), and older participants (51–79, $N = 29$) for (a) the number of topics and (b) an average number of facts per topic. Note that while the graphs show the results of different groups, our analysis treats age as a continuous variable. See the online article for the color version of this figure.

Relationship Between Self-Reported Feelings of Interest and Curiosity and Disengagement

A linear mixed-effects model of self-reported feelings of curiosity predicting self-reported feelings of interest revealed a strong positive relationship between the two, $\beta = 0.460$, $z = 21.730$, $p < .001$.

Additionally, we investigated the relationship between disengagement from a topic and self-reported feelings of interest and curiosity (see Table 4). Due to the high correlation between self-reported feelings of curiosity and interest, curiosity and interest ratings were analyzed in separate models. As the likelihood of disengagement increases when more facts within a topic have been read, we control for this by adding the position of the fact within the order of presentation as a covariate. Only self-reported feelings of interest significantly predicted disengagement, $\beta = -0.196$, $z = 5.319$, $p < .001$, while the relationship between self-reported feelings of curiosity and disengagement points in the same direction but is not significant, $\beta = -0.083$, $z = 1.619$, $p = .105$.

To see if age moderated these relationships, we added age to the analyses. In both analyses, increased age predicted a lower chance of disengagement (*curiosity*: $\beta = -0.032$, $z = 5.433$, $p < .001$; *interest*: $\beta = -0.032$, $z = 5.402$, $p < .001$), replicating the results above. However, neither of the analyses showed a significant interaction effect of self-reported ratings and age (*curiosity*: $\beta = 0.005$, $z = 1.118$, $p = .264$; *interest*: $\beta = 0.002$, $z = 0.791$, $p = .429$).

Switch Costs

To explore the possibility that age-related differences in patterns of information seeking represent strategic decisions to reduce

Table 4
Results of the Mixed-Effects Models Investigating the Effects of Self-Reported Curiosity and Interest on Disengagement

	Self-reported curiosity				Self-reported interest			
Parameter	Est	*SE*	*z*	*p*	Est	*SE*	*z*	*p*
Simple model								
Fact position[a]	0.752	0.070	10.680	<.001	0.774	0.076	10.257	<.001
Self-reported measure	−0.083	0.051	1.619	.105	−0.196	0.037	5.319	<.001
Age included								
Fact position[a]	0.736	0.069	10.715	<.001	0.758	0.074	10.205	<.001
Self-reported measure	−0.212	0.127	1.712	.087	−0.265	0.093	2.853	.004
Age	−0.032	0.006	5.433	<.001	−0.032	0.006	5.402	<.001
Age × Self-Reported Measure	0.005	0.004	1.118	0.264	0.002	0.003	0.791	.429

Note. Est = Estimate; *SE* = standard error.
[a] Position of fact within reading order.

cognitive demands that differ with age, we examined whether participants experienced a switch cost to change topics. We performed two additional exploratory analyses of the times participants took to read each fact, considering whether they had changed topics. Note that the reading time we recorded includes the genuine reading time for the fact and the time to rate a question about the fact. Therefore, this is not a pure measure of reading time for the fact. To account for individual differences in reading speed, reading times were standardized within each participant. Average reading time right after a topic change occurred was significantly longer than the average reading time right before a topic change, $t(496) = 2.61$, $p = .009$, $d_z = 0.12$. These results suggest that there was a cost to switching topics. However, a correlation of switch cost with age revealed no significant relationship, $r(495) = .007$, $p = .878$.

Discussion

Previous research suggests that there are individual differences in the type of information-seeking people prefer (Lydon-Staley et al., 2021): Some people prefer to deepen their understanding about one or a handful of topics (i.e., specific information seeking), while other people look for information from a wide range of topics (i.e., diversive information seeking). Using a relatively unconstrained, noninstrumental information-seeking task, we found that age was associated with a shift in information-seeking styles. Specifically, people viewed proportionally more facts from fewer topics as they grew older in comparison to younger adults. Thus, our results suggest that people shift from diversive to specific information-seeking styles as they get older.

Noninstrumental information seeking is often viewed as a manifestation of curiosity. To investigate how information-seeking behavior is linked to self-reported feelings of curiosity and interest in our paradigm, we conducted additional analyses. We found that self-reported feelings of curiosity are strongly related to self-reported feelings of interest within our paradigm. This corresponds to views that feelings of curiosity and interest are part of a shared mechanism (see Murayama et al., 2019). This shared mechanism is proposed to support information-seeking behavior. Similarly, in our paradigm, when self-reported interest decreases within a topic, disengagement from that topic becomes more likely (i.e., specific information seeking). While a similar analysis with self-reported curiosity revealed a trend in the same direction, this trend was not significant. This is likely due to the temporal distance of the curiosity ratings from the decision to either stay or leave a topic, as these ratings were conducted before participants had read the new fact, whereas interest ratings were made prior to deciding whether to stay within the same topic or move to a new topic. Additionally, age neither significantly interacted with the subjective feelings of curiosity nor the subjective feelings of interest when predicting disengagement. This demonstrates that the relationship between self-reported curiosity and interest in information-seeking behavior is not influenced by age. Instead, age might affect knowledge seeking as a whole with both its emotional (feelings of curiosity and interest) and behavioral (noninstrumental information seeking) components. This should be investigated in further experiments as well as in the context of diversive information seeking.

The age-related increases in specific information seeking might be linked to increased prior knowledge in older adults (see Introduction). While both younger and older adults had little knowledge about the specific topic, participants might have differed in how much they knew about the broader area a topic came from. Indeed, we found that the greater the participants' prior knowledge of a topic, the more strongly they engaged in specific information seeking for that topic. Additionally, we found that people with higher overall prior knowledge about the topics within a theme showed less diversive information seeking. These preliminary results support the role of prior knowledge in specific and diversive information-seeking behavior. However, our study was not designed to investigate the role of prior knowledge, and we deliberately picked topics that would most likely be unknown to participants. Hence, future studies are needed to deepen our understanding of this link.

Another possibility is that people use different strategies to make their learning more efficient, depending on their age. For example, previous research has shown that after reaching adulthood, people experience higher switch costs with increased age, making it harder to switch between different tasks or sources of information (Cepeda et al., 2001; Reimers & Maylor, 2005). Switch costs can also be found between different topics within a reading task. When participants consume new information, it is either accommodated into an existing narrative or used to formulate a new one, depending on the level of existing knowledge. Switching to a new narrative has been shown to come with a particularly high cost (e.g., switch cost), both for younger adults (Zwaan et al., 1995) but even more so for older adults (Noh & Stine-Morrow, 2009) and switch costs have been shown to impact reading behavior and memory (Liu et al., 2016). We conducted an analysis on switch costs in our experiment to identify if participants might avoid diversive information seeking because they experience increasing switch costs with higher age. An analysis of reading time showed that the first fact that participants read after switching the topic took more time to read than the last fact that they read before switching the topic, revealing the cost of switching to another topic. However, our results also showed that this reading time difference (before and after switching the topic) was not significantly different between younger and older adults. This could mean that switch costs might not have played a strong role in our paradigm. However, it is important to note that the reading times we have collected might not be an adequate measure of switch costs. Unfortunately, we only had reading time measures that included both the time that participants took to read a fact and the time they took to report whether they had already known the fact or not. This means that our measure of reading time did not only include the time participants took to read the facts, which in turn might have impacted the results of our analyses. The exact role that switch costs play in age-related change in information-seeking strategies still needs to be determined.

Results from the present study also provide some novel insights into the research on developmental changes in curiosity—a broader motivational construct behind noninstrumental information-seeking behavior. Previous studies assessed self-reported subjective feelings of curiosity and examined their relationship with age, but the results were not consistent. Experimental studies observed an age-related increase in the degree of self-reported feelings of curiosity induced by experimental stimuli (Galli et al., 2018; McGillivray et al., 2015; Swirsky et al., 2021). However, other studies (mostly based on self-report questionnaires of one's reflection on his/her everyday curiosity experience) often observed age-related reductions in self-reported feelings of curiosity (Robinson et al., 2017). On the other hand, our study found both positive and negative trends depending on the type of information-seeking behavior. Although speculative, these findings suggest that previous inconsistent results may be explained by these two different types of information-seeking behavior. Future research needs to examine how self-reported feelings of curiosity are assessed in different ways and how they are related to different types of noninstrumental information-seeking behavior.

Several limitations of the present study should be noted. First, although we have a comparatively large sample size of 500 participants, the data included a relatively small proportion of "older adults" due to the convenience sampling approach to participant recruitment (see Figure 2). Therefore, while our study demonstrated the gradual and continuous shift from diversive to more specific information-seeking behavior across adulthood, our data are not sufficient to detect a qualitatively different pattern that could happen when people become older adults. Second, all participants in the present study were visitors to the museum, so they are likely to be curious people, and cultural engagement, like going to museums, is also associated with higher socioeconomic status (Steptoe & Zaninotto, 2020). This is also reflected in their high level of education.

Third, we examined participants' noninstrumental information-seeking behavior, but participants had little control over the facts that they wanted to see (i.e., facts were presented in a random order). However, there are many occasions in our daily lives where people take more control over what information they view (e.g., specific Google searches). Previous research found that participants who were presented with facts in a random order disengaged more quickly from a topic than participants who were able to select facts themselves (Fastrich & Murayama, 2020). Thus, it still needs to be investigated how adult development impacts information-seeking tendencies when participants have more choices about the facts they are consuming. Future research needs to investigate whether age-related changes in information-seeking styles are observed across samples with lower levels of education.

Taken together, this study shows that while younger adults are motivated to find out more about new information from novel topics, older adults prefer to deepen their understanding of topics they are already familiar with. This has implications for how communication—for example, in the health or public sector—should be adapted to different age groups: older adults might be more inclined to learn new facts if they are presented in a context of topics that are already familiar to them and might benefit more strongly if topics are communicated in greater detail. On the other hand, younger people are more drawn to information from novel topics but are not always inclined to explore these topics more deeply. Thus, younger people might be more inclined to learn brief facts of novel information and, overall, more receptive to learning information from areas they yet know little about.

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