APPENDIX. MULTIMODAL USER DATA USED FOR USER ATTRIBUTE INFERENCE

Dimension	User attribute	Online behavioral features extracted from search logs and screen recording data	Eye movement features extracted from eye-tracking data	References
Background	Demographic information	time spent on SERP, total navigation time, number of query reformulations, number of pages visited, total number of queries, mean numbers of terms per query, average rank of selected document	number of fixations on abstract, fixation duration, length of the scanpath	Nori et al., 2020; Ford et al., 2001; Lorigo et al., 2006
	Past experiences and memories	+number of search approaches, +number of pages visited, - number of errors in query, - time to complete the task, - number of queries, + number of search terms per query	+number of fixations+, + fixation duration	Slone, 2003; Okhovati et al., 2017; Thatcher, 2008; Muntinga & Taylor, 2018
	Knowledge and familiarity	+number of terms, + time spent check the query, + number of combining search terms, - number of pages visited, + number of queries, + query length, + number of keywords contained per query	+number of reading fixations+, + fixation duration, + total length of the scanpaths	Hsieh-Yee, 1993; Sanchiz et al., 2017b; Bhattacharya & Gwizdka, 2018
	Interest and involvement	+total time spent on a page, + number of mouse clicks on a page, + time spent moving the mouse, + time spent scrolling by the mouse and the keyboard, + number of pages bookmarked	+pupil size, + total number of fixations, + fixation duration	Claypool et al., 2001; Gwizdka, 2014
Expectancy	Task expectancy	+number of queries, + query length, + number of unique query terms, + number of clicks on SERPs, + number of URLs visited, + time spent completing search tasks	+total fixation duration, + number of fixations on the page, + perceptual span (average separation of fixations), +number of regression fixations	Kelly et al., 2015; Cole et al., 2015
	Emotional expectancy	+number of viewing hits, + time spend searching, - number of unique queries, - time examining each SERP		Zanganeh & Hariri, 2018
Experience	Task experience	+search dwell time, + maximum clicked rank, + number of clicks, - number of queries, - query length, - frequencies of using query suggestions, +number of results clicked, + SERP dwell time, + number of query terms, + number of search results clicked, + average rank of all clicks, + total number of pages bookmarked, + total number of mouseovers, + total scroll distance	+fixation duration, + slope between two fixations, + the saccadic curvature, + average travel time, + the existence of regression fixations, + the spacing of fixations, + reading speed	Liu et al., 2015; Jiang et al., 2015; Arguello, 2014; Wu et al., 2019

	Emotional experience	+search duration, + number of pages visited, + query length, + max page scroll, + number of unique queries, + number of user actions in the task, + average number of URLs visited	-number of fixations, - time to first fixation on search box, - time to first fixation on relevant browsing element	Feild et al., 2010; Kuhar & Merčun, 2022; Fehrenbacher, 2017
	Cognitive experience	+search result clickthrough rate, + page dwell time, + clicks on SERP, + the result ranking		Shokouhi et al., 2015; White, 2013
System evaluation and usage	System evaluation	-number of clicks on the abstracts, + click ranks of abstracts	-total number of fixations, + pupil dilation, - the average number of fixations, - number of fixations on the abstracts	Pan et al., 2007
	Usage intention	+number of unique queries, + number of query refinement operations, + number of re-sorting operations, + number of visual inspection and scrolling operations	+fixation duration, + number of fixations	Hoeber, 2013; Menges et al., 2019

Note: "+" means positive correlation. "-" means negative correlation.

Additionally, information retrieval studies collected facial video and audio data, and then extracted users' facial expressions features and verbal commentary features to predict user attributes. Specifically, regarding facial video data, researchers analyzed users' facial expressions such as happiness, sadness, anger, disgust, fear, surprise and neutral to predict users' background (e.g., age (Wu & Huang, 2018) and internet search experience (Zanganeh & Hariri, 2018)), experience (e.g., perceived task difficulty (Arapakis et al., 2008), emotional experience (Fehrenbacher, 2017), and search task satisfaction (Zanganeh & Hariri, 2018)), and system evaluation (Arapakis et al., 2009). Regarding audio data, researchers have found that user's verbal comments during the search interaction are significantly correlated with their background (e.g., prior knowledge and ability (Mason et al., 2011) and past search experience (Muntinga & Taylor, 2018)), experience (e.g., cognitive experience (Hinostroza, 2018) and perceived task difficulty and emotional experience (Menzi Çetin & Akkoyunlu, 2022)), and system evaluation and usage intention (Vilar & Žumer, 2008).

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