Introduction to the Special Focus: Remembering Sarah DuBrow

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This Special Focus of the *Journal of Cognitive Neuroscience* is dedicated to the research legacy of Dr. Sarah DuBrow. Sarah Dubrow passed away in February 2022 at the young age of 35 years, only 4 years after opening her own laboratory at the University of Oregon. Although her career was all too brief, Sarah made a timeless impact on our community of memory researchers. In this Special Focus, we have collected articles that include the final chapter of her dissertation, empirical articles, theoretical reviews, and an essay highlighting her role as a laboratory mate, collaborator, and mentor. Here, in the Introduction, we highlight the impact of her scientific findings, and, more importantly, we share a holistic perspective of Sarah that we gained as her graduate school mentor (Lila Davachi) and long-time collaborator (Vishnu "Deepu" Murty).

Sarah was always broadly interested in cognition, and memory in particular. Her experience as a research assistant in Anthony Wagner's laboratory at Stanford—where she met her future husband Ben Hutchinson and long-time collaborator and friend Brice Kuhl—armed her with a solid foundation in cognitive neuroscience. When she started her graduate work in my laboratory (Lila), she wanted to crack the code on understanding how separate items become linked across time—a critical step in understanding the very nature of episodic memory. She developed both behavioral and imaging studies, acknowledging that both were needed to gain proper insight into episodic memory. Her first articles established that changes in context, or event boundaries, bookend experiences into holistic episodic memories. She showed these effects using different behavioral assays (cued recall, implicit priming), neural measures (univariate activation, connectivity, machine classifiers), and complex statistical models. Her graduate research contributed to the development of a now widely used experimental paradigm to study event memory that we have named the Ezzyat–DuBrow–Davachi (please use this terminology when using this paradigm to carry on her legacy) Paradigm (Buonomano, Buzsáki, Davachi, & Nobre, 2023; Heusser, Ezzyat, Shiff, & Davachi, 2018; DuBrow & Davachi, 2013), which robustly and reproducibly demonstrates that within-event items are more tightly bound to each other in memory compared with experiences that cross an event boundary.

Sarah's intense interest in temporal memory also extended into a curiosity about time perception, which she, of course, studied as a "side hustle." Through several behavioral and imaging studies with Brynn Sherman, she elegantly characterized that temporally unfolding color displays with color switches, or boundaries, led to the perception of time being compressed at short timescales. Across two paradigms—one measuring longer term memory (Ezzyat–DuBrow–Davachi Paradigm) for temporal order and the other measuring subjective time estimates—she uncovered a mystery that seemed inconsistent at face value but, alas, made perfect sense as the depth of Sarah's contributions revealed the underlying mechanisms: Event boundaries disrupt ongoing memory integration because they flush working memory representations, which contribute to our estimates of time passing. Thus, without the whole event's temporal information accessible when making time perception judgments, we underestimate how much time has passed. Brilliant! During her postdoctoral fellowship (with Yael Niv and Ken Norman) and in her own laboratory, she extended these ideas to more broadly understand what constitutes an event boundary by exploring different types of drifting contexts, such as task switching. She dove deeper into the mechanisms underlying time perception and temporal memory, and she applied these memory-based frameworks to the domain of causal learning.

The foundational tenets of Sarah's research program have inspired new trajectories of research across the fields of learning, memory, and decision-making, as illustrated by the three themes highlighted in this Special Focus. The first theme dives deeper into the mechanisms underlying boundary effects on memory, including Sarah's dissertation work highlighting a causal role for the hippocampus in event memory (DuBrow, Sherman, Meager, & Davachi, 2024), a novel fMRI approach to characterize how varying cortical regions integrate boundaries into memory across different timescales (Lee & Chen, 2024), and a computational model of boundary generation in the context of short and long timescales (Smith, Thompson-Schill, & Schapiro, 2024). This theme is complimented by a theoretical review of how event segmentation occurs in the context of repeating events (Zou & Kuhl, 2024). The second theme broadens the scope of Sarah's research to understand how individuals organize multiple events into higher-order structure, including a study querying

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memory organization in the context of varying retrieval goals (Antony, Lozano, Dhoat, Chen, & Bennion, 2024), a review that posits a critical role for the hippocampus in bridging the gap between prior and current events to structure memory (Rait & Hutchinson, 2024), and a computational model characterizing how different neurotransmitter systems balance memory integration versus separation processes depending on the nature of context switches (Rouhani, Clewett, & Antony, 2024). The third theme extends Sarah's postdoctoral research and studies originating from her own laboratory to understand how event memory intersects with goal-states during encoding to structure memories more adaptively, including studies characterizing the modulatory role of task switching (Cowan, Chanales, Davachi, & Clewett, 2024), threat avoidance (Horwath, Katerman, Biju, DuBrow, & Murty, 2024), and latent cause learning (Mirea, Shin, DuBrow, & Niv, 2024).

So far, we have briefly summarized Sarah's scientific contributions and the wealth of work that was inspired by hers. However, as we have come to learn and are still learning, in science, we come for the data but stay for the colleagues, a notion encapsulated by an essay included in this Special Focus (Tompary, deBettencourt, & Rouhani, 2024). It is impossible, nay even unjust, to discuss Sarah's truly impactful science without honoring Sarah, the beautiful, playful, infectious human. The scientist, Sarah, was ever curious, steadfast, hardworking, and brilliantly talented. When working on a question, researching the literature, designing an experiment, or analyzing the data, Sarah worked with intensity and focus, always searching for the truth. She was not one to want to move quickly through a project lest she leave an important stone unturned. Past work was as fulfilling for her scientific curiosity as was her own research; she knew she could learn what she needed from both. She read voraciously, which made her an incredible scholar and eager to learn all of the early theories and experimental data on sequential memories and how they are formed. Moreover, research was always about the science for Sarah, and she was never distracted by politics or prestige. When faced with theoretical disagreements or when her work was overlooked, Sarah would respond with data. She cut straight to the science and would write an inclusive commentary to bridge the sets of findings.

Sarah's vigor and enthusiasm for research spread into every aspect of her life. A lot of people talk about "work–life balance" in the field, but this idea was the antithesis of her being. Some may see this as a negative, as if she was sacrificing parts of her life for science. However, for Sarah, thinking about science brought her joy. Among her friends, the fondest memories of Sarah involve seamlessly drifting in and out of talking about research amid playing board games, cooking dinner, or grabbing drinks at the bar. To many, this may seem like she was a boring conversational partner, but to paraphrase Brice Kuhl, Sarah made talking about research feel like it was the "hottest piece of gossip." She would also apply her same rigor for science to all aspects of everyday life. On a laboratory weekend retreat, she insisted on organizing a blind taste test of local beers on five different factors, while making sure that order of sipping was counterbalanced across raters. However, it was not enough to determine which beer was the best; rather, she saw this event as an opportunity to generate multidimensional plots to visualize how close each of the laboratory members were using multidimensional scaling approaches in "beer space" (Figure 1). Scientific inquiry was always at the core of her being.

This approach of fusing work and life also allowed every laboratory mate and collaborator to enjoy the gift of her friendship. This magnetized everyone she was friends with to want to work with her. Indeed, most of the contributors to this Special Focus did not have an intrinsic interest in temporal memory or event segmentation (excluding Lila of course). However, Sarah's passion about her research was infectious, and somehow you ended up seeing your own work through her eyes. This exchange of scientific thought was bidirectional, driving Sarah to integrate the theories and methods of laboratory mates and peers into her own work effortlessly. As someone who entered my postdoctoral fellowship refusing to study temporal context or retrieval more broadly, I (Deepu) find that half of my research program has incorporated these ideas because of conversations we had together.

There is no way to fully embody the true force of nature that was Sarah Dubrow, but there is also no way that we could not try. This Special Focus embodies so much of what Sarah loved about research, deeply thinking about hard, but core, problems. This Special Focus only begins to scratch the surface of how much she inspired the field as a colleague, mentor, and friend. She will be greatly missed by many, but we have no doubt that her brilliant mind and awesome approach to being a scientist will

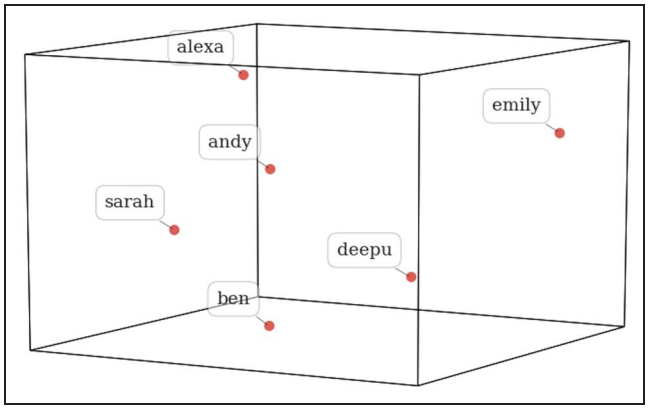

Figure 1. A representation of distance in beer preferences using multidimensional scaling on ratings across six dimensions (can appearance, beer appearance, aroma, mouth feel, taste, and gestalt/overall) and seven beers in a subset of the Davachi Lab circa 2016 (Emily Cowan, Sarah DuBrow, Andrew Heusser, Deepu Murty, Alexa Tompary) and special guest Ben Hutchinson. The x, y, and z dimensions represent the top 3 principal components across the data set.

be carried on through her published work as well as through all of us and others who were lucky enough to work with her.

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Author Contributions

Lila Davachi: Writing—Original draft; Writing—Review & editing. Vishnu P. Murty: Writing—Original draft; Writing—Review & editing.

Diversity in Citation Practices

Retrospective analysis of the citations in every article published in this journal from 2010 to 2021 reveals a persistent pattern of gender imbalance: Although the proportions of authorship teams (categorized by estimated gender identification of first author/last author) publishing in the *Journal of Cognitive Neuroscience* (*JoCN*) during this period were M(an)/M = .407, W(oman)/M = .32, M/W = .115, and W/W = .159, the comparable proportions for the articles that these authorship teams cited were M/M = .549, W/M = .257, M/W = .109, and W/W = .085 (Postle and Fulvio, *JoCN*, 34:1, pp. 1–3). Consequently, *JoCN* encourages all authors to consider gender balance explicitly when selecting which articles to cite and gives them the opportunity to report their article's gender citation balance.

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