Amy H. Criss, June 2017

Overview of Research

The broad goal of my research program is to understand memory. Perhaps no other function of the cognitive system is as important as memory, nevertheless the basic processes underlying the human memory system are not yet fully understood. To best facilitate the development of a comprehensive and accurate model of memory, I have focused on testing existing models with the goal of identifying the core assumptions and critical data necessary for building a comprehensive model memory. The majority of models actively in use are task-specific, preventing a coherent integrated understanding of memory (see Criss & Howard, 2015). The long term goal of my research program is to resolve that problem by developing an inclusive model of memory and we present a conceptual framework within which to do so in Cox et al (submitted).

Core Assumption I: updating memory traces produces differentiation

One prominent area of my research has been to conduct a programmatic and thorough investigation of differentiation (see Criss & Koop, 2015 for a review). Differentiation is the principle that the more that is known about an item, the less confusable that item is with other items. Within the context of episodic memory models, this takes the form of updating memory traces for an event. The more complete a given memory trace, the more likely that it will be remembered (increasing hits) and the less likely that it will be mistaken for a foil (decreasing false alarms). Models with a mechanism for updating episodic memory traces were revolutionary in that they could account for data that no other models could (REM: Shiffrin & Steyvers, 1997 and SLiM: McClelland & Chappell, 1998). Although the details differ and in some cases the models make different predictions (Criss & McClelland, 2006), they share the core assumption of differentiation by updating individual memory traces.

Much of my research has been investigating the predictive power of this differentiation mechanism during initial encoding of the event. One approach is to generate and test critical predictions from the models incorporating differentiation. REM predicts an interaction between the degree of updating and the similarity between targets and foils; predictions which were confirmed for both younger (Criss, 2006) and older adults (Criss, Aue, & Kilic, 2014). Another approach is to evaluate the empirical evidence for differentiation during encoding against an alternative hypotheses. We have obtained converging evidence for differentiation rather than alternative models from a wide range of domains including response time distributions (Criss, 2010), participant-generated distributions of subjective memory strength (Criss, 2009), neural signatures (Criss, Wheeler, & McClelland, 2013), and response dynamics (Koop & Criss, 2016).

Retrieved memories are better able to be remembered at a later time, but this retrieval harms accuracy for subsequently retrieved memories (Malmberg et al, 2014). Learning during retrieval results in a decrease in accuracy across a series of retrieval attempts, so long as retrieval is from episodic, not semantic memory (Annis et al, 2013; Aue et al, 2015). This detrimental effect of retrieval, called output interference, can be eliminated when the similarity of the test material changes (Criss et al, in press; Malmberg et al, 2012) but is unaffected by feedback (Koop, et al, 2015). The effects of learning during retrieval are best explained by a model where remembered memory traces are updated with the same differentiation mechanism used during initial encoding (Criss et al, 2010). In Kilic et al (2017), we explore the empirical and theoretical relationship between differentiation during encoding and during retrieval

Core Assumption II: items and associations are independent

Beginning with my dissertation, I have conducted a systematic evaluation comparing memory for individual items to memory for associations between those very same items, addressing one of the oldest questions in cognitive psychology – what is the relationship between the whole and its parts. The properties that cause interference in memory for single items differs from the properties that cause interference in memory for associations including the type of stimulus (Aue, Criss, & Fischetti, 2012; Criss & Shiffrin, 2004c; Criss & Shiffrin, 2005), the normative frequency and diversity of the individual words (Aue, Fontaine, & Criss, in revision; Criss, Aue, & Smith, 2011) and encoding strength (Wilson & Criss, in press). These findings suggest some degree of independence between item and associative information. In Cox & Criss (submitted), we leveraged systems factorial technology to provide qualitative model-independent evidence that item and associative information provide independent contributions that are retrieved in parallel and mutually facilitate one another. Having established the necessary empirical data, we are now working on developing a model that successfully accounts for both memory for items and memory for associations.

Core Assumption III: memories interfere with one another

Understanding the degree of interference caused by different sources of information is critical to theory development because memory is quite imperfect and models must be able to accurately predict the source of this imperfection. My research has established that information identifying the item and the surrounding contextual details both cause interference. The amount of interference increases as the number of items similar to the test item increases during study (Annis et al, 2015; Criss & Shiffrin, 2004a) and during test (Criss et al, 2011; Malmberg et al, 2012) and as the similarity between contextual information at study and test increases (Criss & Shiffrin, 2004a; Howard et al, 2015; Kilic et al, 2013; Klein et al, 2007). Items with orthographically common features suffer more interference than items with orthographically distinct features and this interference can be mitigated by shifting encoding to semantic rather than orthographic features (Criss & Shiffrin, 2004b; Criss & Malmberg, 2008) although this pattern of data is more complex than originally thought, suggesting a role for prior knowledge (Hemmer & Criss, 2015).