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Discoveries about Infant Language Learning and "Readiness to Learn" from Integrated fNIRS, Thermal IR, Robot, and Avatar Sciences

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Integrative Statement

Our symposium lays bare a new science initiative that pushes the boundaries of traditionally separate sciences to advance childhood language learning (fNIRS neuroimaging, Robotics, Avatars/Virtual Humans, and Thermal IR Imaging). We describe our creation of an innovative research platform, called the Robot AVatar thermal-Enhanced learning tool ("RAVE"), a single integrated system, which makes available multiple components of language in socially contingent, interactive, and conversational ways for all children, especially children with minimal language experience during sensitive periods of learning and development (Fig 1). Early-life minimal language experience has a devastating impact on children's capacity to learn language and reading (e.g., Caskey et al., 2014; Nelson, 2000) with some children being at an especially high risk (e.g., deaf infants who can have no early-life natural language experience). We (1) advance new answers to basic science questions using fNIRS neuroimaging about how all infants discover their native language phonology—be they deaf acquiring signed languages or hearing acquiring speech—thus providing knowledge vital to advancing healthy language learning and reading success; (2) explain novel physiological measurement of emotional arousal/attentional valences in infants using thermal infrared imaging specifically relating to higher cognition and learning, thus providing groundbreaking knowledge about when infants are most optimally "Ready to Learn;" and (3) demonstrate a first-time interaction using joint attention and socially-contingent conversation between an infant, robot, and virtual human. Our symposium's broader impact objectives are to identify ways that early learning gains can be imparted to all children through the revolutionary integration of science and technology.

Figure 1. Components of the Rave system