Multisensory Function: A Balancing Act across the Lifespan

We all have eyes, ears, hands, a nose, and a tongue. Each of these organs allow us to perceive our world and to interact with one another in socially appropriate ways. Importantly, even though each organ provides independent sensations to our brain, ultimately our senses must work collaboratively to generate adaptive behavior and coherent perceptions. This is illustrated by the fact that we perceive a bouncing ball as a unitary event rather than as an image of a moving object and a disconnected impact sound.

Currently, we know little about the ways in which our brains integrate multisensory information and how this changes across our lifespan. In their review published in the August issue of Trends in Neurosciences, Murray et al. provide a new perspective on how multisensory functions operate and change as we move from childhood to old age. They argue that two processes work hand-in-hand to build unitary multisensory representations of our world. The first of these processes relies on the physical characteristics of the perceptual attributes that specify our world, such as their relative location, timing, and intensity. These physical characteristics are used by the brain to determine which of them should be “bound” into a single perceptual entity, thereby giving us a unitary perceptual experience, and which should be treated as belonging to different entities. To illustrate, the reason that we treat a bouncing ball as a unitary event is because we can detect the spatial and temporal correspondence of their visual and auditory attributes. The second of these processes is of a “higher order”. It relies on the task at hand and the multisensory associations that we have formed through our short-term and long-term experiences. Such experience enable us to learn to link various multisensory attributes based on more than just their physical characteristics; they allow us to link them based on various contextual cues, our interests, and sometimes motivations. Think of the sight and sound of a family member. It is through your interactions with them that you build strong linkages between the sight of their face and the sound of their voice and that those linkages come to represent specific people that have specific meanings to you beyond the fact that they clearly go together in time and space whenever you encounter them.

The review highlights that these two processes are not static, but rather dynamic and that they continually interact with one another both across the lifespan and in real time. Specifically, the relative weighting or balancing of these two processes changes across the lifespan. Early in life, we depend primarily on the first process and the low-level statistical relations that automatically bind multisensory stimuli. In contrast, later in life, by which time we have gained a great deal of experience with our world and developed a more sophisticated behavioral repertoire, we become more reliant on the second process. The most intriguing part of this developmental process is that, by the time we reach adulthood, we become capable of flexibly shifting between our reliance on the low-level versus higher-level multisensory binding processes depending on context and task demands.

This review assembles for the first time 4 leading international scientists with expertise in multisensory processing. Micah Murray (University Hospital and University of Lausanne, Switzerland) is a pioneer in the study of multisensory influences in human primary cortices and on memory functions in adults. David Lewkowicz (Northeastern University, Boston, MA, USA) is a leader in understanding the development of multisensory processes in human infants. Amir Amedi (Hebrew University, Jerusalem, Israel) is among the vanguard of scientists showing how sensory substitution is an effective means for the restoration of visual functions and at the same time as an elegant tool to study fundamental basic science
questions in Multisensory processing and brain plasticity. Mark Wallace (Vanderbilt University, Nashville, TN, USA) is at the forefront of characterizing multisensory function across the lifespan at the neural and behavioral levels, their link to cognition, and how these functions are altered in clinical populations.

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The full article can be freely downloaded at:
http://www.cell.com/trends/neurosciences/fulltext/S0166-2236(16)30048-0