**Synesthesia** is a neurological condition in which perception of a stimulus triggers an automatic experience from two or more senses that are unrelated [6]. Synesthesia represents a relationship between an inducer (the physical stimulus, such as a written letter) and a concurrent (another sensory response, like the color yellow). Many different forms have been documented – including sound-color, grapheme-color, and personification (in which written symbols take on personalities) [3]. This disorder is currently diagnosed using memory-based assessments of associations with concurrents, as synesthetes display enhanced learning and memory retention [5]. While the specific mechanism is not known, synesthesia phenotypes have been attributed to overlapping of sensory neuronal networks and a disruption in standard synaptic pruning [4]. *ROBO3* – a regulatory gene in the axon guidance pathway which directs neuronal network development – has been found to be mutated in people with sound-color synesthesia. *However, it is not currently understood how the role of ROBO3 in the process of axon guidance relates to enhanced learning through color perception.*

This gap in knowledge should be explored because it has implications for improving education and for better understanding evolutionary reasons for color perception. The **objective** of this project is to identify specific ROBO3 mutations that cause aberrant axon development which impact color perception and learning. I **hypothesize** that ROBO3 mutants will be able to learn information received through color perception more quickly than unmutated model organisms. This hypothesis is supported by research exploring the role of ROBO3 mutations in *Drosophila* photoreceptor development, and by the human phenotype of increased memory efficiency of color-associated recall for synesthetes [1, 5]. My **long-term goal** is to analyze how color perception impacts learning and memory development for diverse species.

**Aim 1: Identify specific protein domain regions within ROBO3 that contribute to color perception.**

**Rationale:** Identifying regions of ROBO3 strongly correlated with color perception will help develop candidate mutations to be studied in further assays.

**Approach:** First, NCBI BLAST searches will be used to find ROBO3 homologs in diverse species with varied color perception and visual systems. Then, PFam will be used to identify the types of protein domains that are conserved within the homologs. Individual homologous domain sequences will be aligned using MEGA, and maximum likelihood phylogenetic trees will be built for each domain type. Analyzing the tree clades for similarity in visual system organization and color perception ability, conserved SNPs can be identified. These domain SNPs will be introduced into zebrafish models, which will then be sent through a color-driven maze assay and timed upon repeated attempts in comparison with control wildtype zebrafish [2].

**Hypothesis:** Protein domain regions in ROBO3 that are highly conserved among groupings of organisms with more complex visual systems, and potentially absent in organisms lacking visual systems and eyes, will be found to be significant in color perception. Zebrafish mutants will learn how to navigate color-driven mazes more quickly than wildtype zebrafish.

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