**Exposing Piaget’s Scheme**

**Empirical Evidence for the Microgenesis of Coordination**

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**ABSTRACT**: 76 participants (9-14 yo) solved table-based non-symbolic manipulation tasks designed to foster grounded meanings for the mathematical concept of proportion. Successful task performance coincided with spontaneous appearance of stable dynamical gaze-path patterns soon followed by multimodal articulation of strategy. Significantly, gaze patterns included uncued non-salient screen locations. We interpret the findings as enabling us to support, refine, and elaborate on claims from Piaget’s theory of genetic epistemology and in particular his insistence on the role of situated motor-action coordination in the process of reflective abstraction.

**Interactive Design for Learning, Multimodal Data Gathering and Analysis**

The Mathematical Imagery Trainer (Abrahamson) replicated as a touchscreen tablet app that includes parallel as well as orthogonal manipulation. Task: make the screen green, keep it green while moving hands. Screen is green when quantities relate by target ratio.

**Results**

All students spontaneously constructed attentional anchors that first enhanced motor-action coordination and then mediated mathematical discourse. Micro-analysis reveals behaviors interpreted as stages of reflective abstraction: interiorization, coordination, encapsulation, generalization. Thus invented objects serving in the solution of a situated interaction task materialize as discursive referents of mathematical inference en route to conceptual learning.

**Typical Eye-Gaze Patterns**

**Parallel Pluses**

**Parallel Bars**

**Orthogonal Pluses**

**Orthogonal Bars**

**Action Sequence and the Future of Eye-Tracking**

An attentional anchor mediating bimanual coordination in Orthogonal Pluses. Student invents diagonal line between fingers; he manipulates this line, moving it to the right while keeping its angle constant relative to the field. Gaze path traces a linear function. What if the teacher saw this in real time? How about the student?

**Eye-gaze trace lines emerge as linear functions, suggesting future directions for embodied design in mathematics.**

**References**