Comics and cognitive systems: The processing of visual narratives

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Keywords: comics; narrative; visual narrative; autism; perception; event-related potentials

Introduction

Humans have drawn sequential images as a means of expression throughout history, from cave paintings and frescoes to wall-carvings and tapestries (McCloud, 1993). In contemporary society, we find them most prevalently in comics of the world, and over the past two decades, increasing attention has turned to this communicative system in the cognitive sciences.

Earlier work often focused on theory alone, drawing from paradigms in linguistics or semiotics (for review, see Cohn, 2012; Wildfeuer & Bateman, 2016) or from theorists outside academia (e.g., McCloud, 1993). However, newer studies test theoretical predictions with empirical corpus analyses and both behavioral and neurocognitive experimentation. As in language research, combining these methodologies provides converging evidence on the structure of visual narratives, their diversity across the world, and their comprehension by minds and brains.

Recent research has especially focused on the overlapping cognition between the processing of the "visual languages" constituting drawn visual narratives and the linguistic systems of verbal and signed languages (Cohn, 2013; Magliano, Larson, Higgs, & Loschky, 2015). These presentations further such analyses, and explore questions related to the degree to which these visual languages share mechanisms with linguistic and other cognitive systems.

Visual narratives and converging evidence

The first presentation by **Neil Cohn** will provide an overview of this multipronged approach to visual narratives by discussing recent projects in collaboration with Marta Kutas. Many visual narratives use a construction where successive images depict different characters, thereby "conjoining" them into a larger spatial environment containing all the characters (Cohn, 2013). Corpus analysis has suggested that this "narrative grammatical pattern" appears more in Japanese *manga* than in American comics (Cohn, 2013). We used event-related brain potentials (ERPs) to determine whether comprehension of such "visual narrative conjunctions" invokes "grammatical" combinatorial processing in addition to incremental mental model updating in wordless visual narrative sequences. We crossed (non)conjunction sequences with (in)congruities. Conjunctions elicited a larger anterior negativity (300-500ms) than non-conjunctions, regardless of congruity, implicating only "grammatical" processes because of its insensitivity to semantic incongruence. Both non-conjunction and incongruity elicited larger P600s (500-700ms), indexing a process of mental updating or reanalysis (Cohn & Kutas, 2015; Kuperberg, 2013). Finally, regression analyses revealed that both neural conjunction effects were modulated by participants' frequency of reading manga while growing up: A greater anterior negativity in frequent manga readers suggested more reliance on combinatoric processing, while larger P600 effects in infrequent manga readers suggested more mental updating. Thus, through converging evidence across theoretical, corpus, and experimental methods, we can see that visual narrative comprehension involves multiple processes modulated by fluency in specific "visual languages."

Understanding the moment-to-moment processing of sequential narratives

It is the aspects of mental model updating where we find the most overlap between research on the moment-to-moment processing of visual and text-based narratives. This is particularly true for investigating the role of inferences in mental model construction. In this presentation, **Joseph P. Magliano** (along with co-authors John P. Hutson, Adam M. Larson, Karyn Higgs, & Lester C. Loschky) present a mix of recently published and newly analyzed data that show how processing effort (global picture viewing times) and eye movements are sensitive to mental model construction.

To test this relationship, participants were presented with a visual narrative. The construction of participant mental models was manipulated through the presence or absence of a panel that depicted the bridging event of an action sequence. We predicted that participants who did not see the bridging event would need to generate an inference about

the bridging event in order to construct a coherent mental model of the visual narrative. The data shows that processing pictures in a visual narrative is sensitive to the need to construct bridging inferences and breaks in situational continuity. These results again demonstrate the benefits of converging evidence combining the utility of viewing time data for studying mental model construction in visual narratives, and the role of top-down comprehension processes in generating eye-movements. More importantly, these results speak to the need for a theory of how eye movements and visual narrative comprehension processes are coordinated.

Visual vs. Linguistic Narratives in individuals with Autism

Work presented by **Emily L. Coderre** (along with co-authors Neil Cohn, Sally K. Slipher, Mariya Chernenok, Kerry Ledoux, & Barry Gordon), will further explore the overlaps in processing of language and visual narratives by comparing the cognition of healthy adults with those of individuals with autism spectrum disorders (ASD). Language difficulties are one of the hallmarks of ASD. Previous research has documented particular difficulty with narrative comprehension among individuals with ASD, indicating impairment in understanding and interpreting narratives compared to typically developing controls. However, the majority of these studies have used linguistic stimuli (i.e. written or spoken narratives), making it difficult to determine whether the impairment in narrative comprehension stems from the use of language-based stimuli, which individuals with ASD have difficulty with overall, or from a more global impairment in narrative comprehension. The current study aimed to address this question by analyzing the N400 ERP component, which is shown to be elicited by incongruous stimuli in both linguistic stimuli (sentences) and sequential images (visual narratives), to directly compare semantic comprehension of linguistic narratives (a series of short sentences) and visual narratives (a series of comic panels) in high-functioning adults with autism (HFAs) and normal controls (NCs). Each narrative ended with either a semantically congruent or incongruent word or image. HFAs showed reduced N400 effects compared to NCs for both linguistic and visual narratives, suggesting impaired semantic comprehension of narratives in both modalities. These results, which suggest that difficulties with narratives in individuals with ASD stem from a more global impairment of narrative comprehension regardless of the stimulus modality, have important implications for the use of visual and linguistic stimuli in intervention and treatment strategies in ASD.

Could any real person look as despondent as Charlie Brown?

The higher-level information in visual narratives must draw from basic aspects of object recognition and scene perception. Our final presentation by **L.N. Kendall** (with co-authors Quentin Raffaelli, Alan Kingstone, Rebecca M. Todd) targets one facet of this lower-level processing: the differences in processing the styles of visual representations.

Iconic representations are ubiquitous in visual narratives like comics, graphic novels, and children's cartoons. While there is some evidence that iconic images are processed differently from photorealistic images, the qualities that serve to distinguish the two are largely unknown. We tested whether iconic representations are uniquely advantageous for communicating emotion quickly and efficiently. In Experiment 1 displayed face stimuli at various presentation times to determine the time necessary to detect an expression on a face. As images became more iconic, their information grew easier to discriminate. Additionally, analysis of ERP components P1 and N170 suggested that as images grew more iconic, they were processed faster. Cartoon images also uniquely showed more negativity in both components. In Experiment 2, we tested if the features of cartoon faces hold any processing advantage when they match real life expressions compared to when they do not, e.g., :) versus :+. Participants categorized faces either with known symbols or arbitrary symbols for mouths. Halfway through the task, they relearned the arbitrary faces as representing emotions. We found that arbitrary symbols as facial features can be learned to represent emotions as well as meaningful symbols, as measured by N170 similarity. These experiments provide converging evidence that iconic representations are unique in their ability to better represent and communicate emotional information.

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