Title

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Deficit or Difference? Assessing Narrative Comprehension in Autistic and Typically Developing Individuals: Comic vs. Text

by

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Abstract

Deficit or Difference? Assessing Narrative Comprehension in Autistic and Typically Developing Individuals: Comic vs. Text

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Notions of accessibility bring to question the perceived deficits in narrative comprehension for autistic people. This deficit has been positioned as having a cognitive processing disposition towards local coherence, rather than global coherence. Rather than a unitary deficit in the individual, reduced performance on inferential narrative comprehension tasks may be an issue of modality. This dissertation adds to research that challenges this unitary deficit assumption, by situating cognitive processing dispositions in different narrative modalities. Furthermore, this project unifies several prominent inferential frameworks, conceptualizing inferential thinking as a continuum of integration, rather than a set of discrete skills. Repositioning Kintsch's (1988) construction-integration theory as an ordinal continuum provides a basis for integrating other inferential-thinking frameworks, and thus theorizing a new cognitive processing disposition. The Integrated Inferential Reasoning (IIR) continuum is anchored by Pearson and Johnson's (1978) text-implicit questions-answer relations (QARs; local), and script-implicit QARs (global). Building off of the idea of degrees of integration, a new level of QAR is introduced, in which the local and global clauses are integrated into one cohesive inferential response. In this study, the impact of narrative modality (comic plus text versus text-only) on inferential reasoning is compared between and among autistic (n=18) and neurotypical adolescents (n=112).

Although the autistic respondents presented deficits in IIR when answering inferential reasoning items following narratives in a traditional text-only format, the situation with the comic plus text format was more nuanced. Considering format alone, the comic plus text did not promote IIR. However, autistic respondents with the highest level of self-rated comic experience performed comparably to their neurotypical peers on both formats. This is consistent with viewing comics not just as a format, but as a literacy.

I present evidence that cognitive processing disposition varies as a function of context. Autistic respondents had a different experience when engaging with narratives in either the comic plus text and text-only format. This line of research provides alternate frameworks for thinking about autism and narrative meaning making. The work suggests that deficit explanations may not be as powerful as a neurodiversity lens in characterizing the experiences of neurotypical and autistic adolescents when they grapple with narrative accounts of social experiences.

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Acknowledgments

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CHAPTER 1: BACKGROUND AND LITERATURE REVIEW

Comprehending written narratives is difficult for many students, but it is particularly challenging for many autistic students. According to the Diagnostic Statistical Manual of Psychiatric Disorders (DSM-V; American Psychiatric Association, 2013) autism is characterized by three primary challenges: social interaction, social communication, and repetitive, restricted, and stereotyped behaviors and interests. These core features can lead to challenges in accessing the social context that situates events, conversations, and narratives (Frith, 2003; & Happe, 1994). Challenges in integrating contextual information (e.g., understanding how the setting of an action might shape its enactment) can impact one's ability to relate to characters and construct contextual meaning from narratives (Capps, Losh, & Thurber, 2000). In addition, there is further evidence that individuals with autism have a preference for focusing on the *local* (e.g., details) over the *global* (e.g., themes, main ideas, or lessons) aspects of an experience (Frith, 2003; Frith & Happe, 1994; Happe & Booth, 2008; Happe & Frith, 2006;). This disposition can impact an autistic person's capacity to draw on inferences needed to gain a coherent understanding of experiences, especially narratives. There are a variety of inferences and question-answer relations (QARs) that promote a rich and coherent understanding of narratives.

Pearson and Johnson (1978) argued for a series of QARs that readers engage in when discussing narratives, specifically a *text-explicit* QAR (e.g., the question and answer are both text-based, and there are explicit cue(s) that signify their relationship), followed by a *text-implicit* QAR (e.g., where the question and answer are both text-based, but there is no explicit cue linking them together), and lastly a *script-implicit* QAR (e.g., where the answer is filled in with a representation of world or knowledge from outside the text-base). These types of QARs align with different cognitive processing dispositions, particularly in the context of autism. For example, a text-implicit QAR requires the linking of propositions and using those propositions as a source of reasoning for inferential thinking. These same skill sets have been found to be associated with activities that are conducive for a local processing disposition (Happe & Frith, 2006; Nuske and Bavin (2011).

Empirical studies have demonstrated how these theoretical frameworks lend themselves to explaining challenges in narrative comprehension for autistic individuals, (Nuske & Bavin, 2011; White, Hill, Happe, & Frith, 2009) both in terms of inferential thinking when comprehending narratives (Nuske & Bavin, 2011; White,Hill, Happe, & Frith., 2009) and in terms of narrative production (Capps, et al, 2000; Losh & Capps, 2003; Rump Kamp-Becker, Becker & Kauschke, 2012). For example, studies have demonstrated that autistic individuals tend to have relative challenges in taking the perspective of particular characters (White, et al., 2009), using language that reflects perspective taking and creating causal links between events (Capps, et al., 2000), identifying main ideas as opposed to details (Frith & Happe, 1994; Happe & Frith, 2006), utilizing context to inform decisions (Frith & Happe, 1994; Happe & Frith, 2006), and engaging in inferences that require the integration of world knowledge (Nuske & Bavin, 2011).

In summary, individuals with autism are known to have a disposition for focusing on details (e.g., strengths in identifying shapes within shapes, tracking details, local coherence) (Frith, 2003; Frith & Happe, 1994; Happe & Booth, 2008; Happe & Frith, 2006; Jones & Klin, 2013; Klin, Gorrindo, Ramsay & Jones, 2009; Klin, Schultz &Volkmar., 2003; Nuske & Bavin 2011; Rump, et al., 2012; Schlooz and Hulstijn, 2014; Van der Hallen, Eversm Brewaeys, Noortgate, & Wagemans., 2015); this as an alternative view than seeing their processing

differences as a deficit in global processing (e.g., understanding theme beyond the details). This processing bias may also lead to relative strengths in making text-implicit inferences (e.g., inferences that integrate the propositional relations among elements of narratives). However, they have relative challenges integrating their world knowledge with the propositions in the narrative to form relatively more global inferences (e.g., purpose of event; Nuske & Bavin, 2011; White, et al., 2009).

In order to efficiently access a narrative, one must integrate their knowledge-base with the narrative to form a situation model (Kintsch, 1988)—a cognitive representation of the narrative. This skill set is especially important for understanding the context that situates the events in the narrative. Because autistic individuals have been posited to have relative challenges with integrating information to understand the impact of context based on central coherence theory (Frith & Happe, 1994), they can often misinterpret situations. Thus impacting the demonstration of different types of reading comprehension skill sets, particularly integrative reasoning between their world-knowledge and postpositional nature of the narrative (Nuske & Bavin, 2011).

This study aims to explore how one's cognitive processing bias (e.g., local vs. global) can impact one's narrative comprehension, specifically comparing comic vs text formats, using the principles and practices of item response theory. More specifically, this study dives into how processing bias can lead to developing strengths in utilizing inferences required for local coherence, while at the same time, developing challenges when in engaging in inferences required for global coherence. Graesser, Singer, and Trabasso (1994) suggest that local coherence refers to the structures and process that organize the elements, constituents, and referents of adjacent clauses in the narrative (e.g., linking information together within the narrative's text-base and being able to recite those connected events); whereas global coherence is established when the individual takes local chunks of information and organizes and connects them in such a way that makes higher order representations (e.g., linking the information together to generate the theme of the narrative).

The remainder of this chapter is a review of the relevant research traditions that bear on the problem of the study—how autistic individuals make meaning when engaging with narratives. The initial topic reviewed is narratives and forms of meaning making, including the value and contribution of one's world knowledge, the role of inferential thinking in this process, the role of coherence, the various types of inferences that favor local vs. global processing, and how the learner constructs meaning from narratives through the use of these various types of inferences and processing dispositions.

This is then followed by an analysis of how these areas relate to autism. Central Coherence, a social cognitive theory, forms the basis of this discussion (Frith, 2003; Frith & Happe, 1994; Happe and Frith, 2006). The Central Coherence framework, attempts to explain the underpinnings of autism, in an effort to better understand the unique challenges an individual with autism faces when accessing narratives. An exploration of empirical studies demonstrates how one's processing bias can impact narrative comprehension when comparing individuals with autism to their typically developing counterparts. Then a discussion of visual narratives in a sequential image format will follow. Cohn (2007) posits a visual narrative grammar theory that attempts to explain the grammatical rules that govern a visual language system (i.e., comics), and how we make meaning from that infrastructure.

Lastly, the research questions will be posed about the protentional influence comics have on narrative comprehension and the methods, results, and discussion sections to follow.

Narratives and Meaning Making

Engaging with narratives can pose many of the same challenges real life social experiences offer. Narratives have a close relationship with everyday experiences since they both involve agents engaging in different actions in pursuit of their own goals, and with their own agendas (Bruner, 1991; Graesser, Singer, & Trabasso, 1994; McAdams, 2006; Reilly, Losh, Bellugi, Wulfeck, 2004). Depending on one's social life experiences, people will have a range of skills and insights when trying to navigate through social situations. This, in turn, can impact how one perceives and interprets narratives because one's knowledge about the agents' goals, actions, and emotions are embedded in our perceptual and social experiences (Losh & Capps, 2003; Trabasso, Secco & van den Broek, 1982;). However, there is not a perfect overlap between narratives and everyday experiences. But nonetheless, knowledge about social interactions and human intentionality can help in comprehending a narrative (Trabasso, 1980; Mar, 2004).

Many of the same thoughts people have about motives, beliefs, and desires can be applied to characters in a narrative and can impact our beliefs about the world bi-directionally, that is narratives impact our world-view, and our world-view impacts how we make meaning out of narratives. (Mar, 2004). Thus, when engaging in narratives—both understanding them and producing them—learners can gain knowledge about problem solving, social interaction, intentionality, feelings, values, morals, and more (Trabasso et al., 1982; Mar, 2004). Other scholars (Graesser, et al, 1994;; Mar, 2004) assert that in order to better understand and connect with the characters within a narrative, learners must understand the psychological or motivational aspects of why a certain event or action took place. Graesser and co-investigators (1994) also suggest that the notion of understanding the different dynamics of the agents in the narrative is essential for deeper comprehension since it helps the learner generate causes and motives that explain why events or actions in the narrative occur.

Just as in real life, when learners engage with a narrative, they are making a series of evaluations, especially about the choices the characters make. Ozyyurek and Trabasso (1997) suggest that the act of making an evaluation is a process where we reflect upon events that affect us and those around us. In addition, they suggest that these evaluations facilitate narrative functions, structures communicative exchanges, supports social-emotional comprehension, provides the basis for understanding and monitoring concerns about one's self and others, and provides a rationale of potential pros and cons of events and actions. They further suggest that an evaluation involves concerns that can be inferred or expressed through the character's goals, plans of action, and outcomes. This helps the learner relate to the characters, monitor the character's well-being, and understand whether the character succeeds or fails based on the character's goal.

Ozyyurek and Trabasso (1997) further suggest that as the learner evaluates the various outcomes, they must weigh the costs and benefits of those outcomes, along with the logic and appropriateness of the character's goals and actions, all while considering the resources that the character possesses. They propose five ways a learner can engage in an evaluation when interpreting narratives: (a) appraisals (e.g., good vs. bad), (b) preferences (e.g., like vs. dislike), (c) emotions (e.g., happy vs. sad), (d) goals, and (e) outcomes—all of which could then be used to explain the character's agenda. They further posit that appraisals may also reflect the cultural norms, goals, or values of the learner, and that the learner can use those values to decide whether or not what the character did was justifiable depending on the unique circumstances of the character.

According to Ozyyurek and Trabasso (1997) the notion of success vs. failure is completely subjective, and is up to the learner to infer, based on their background knowledge, the character's reasons for an action, causes, and/or causal consequences. Another critical part of the evaluation process is emotions, since these can serve as explicit evaluations of whether or not the character is succeeding or failing. They argue that these emotional evaluations can lead to understanding the character's agenda and the appropriateness of what the character wants to achieve. In sum, the process of evaluating serves as a tool to construct a coherent interpretation of the narrative. However, in order to make these appraisals, one must also be sensitive to the causal structure of the narrative.

In order to maximize the value of what the learner gains from narratives, they must be able to integrate the individual parts, such as events that form a causal network, and connect them in ways that generate a deeper understanding of the narrative (Briner, Virtue & Kurby, 2012; Lynch, van den Broek, Kremer, Kendeou, White & Lorch, 2008; Reilly, et al., 2004; Trabasso et al., 1982). Thus making it important for the learner to be sensitive to the narrative's causal structures (van den Broek, Rohleder, & Narvaez, 1996; van Kleeck, 2008), meaning the causal connections within a narrative (Lynch et al, 2008). Lynch and his colleagues (2008) suggest that the more causal connections there are, the more information the learner can retain. However, it is also important to consider how the causal structure is fostered. Gernsbacher, Robertson, Palladino, and Werner (2004) posit that to better comprehend these connections, one must utilize key information, such as repeated mentioning of characters and other details, just as one would do during a typical dialogue. Engaging in these processes helps the reader create a rich representation of the narrative (Kintsch, 1988), and invites the learner to make inferences to understand the connections between them (van den Broek, et al., 1996; van Kleeck, 2008).

Integrating these causal relations result in the learners' perceived level of coherence of the narrative (van den Broek, 1990). van den Broek (1990) further argues that the integration of these causal relations, and the construction of these relatively larger representations, can be seen as a problem-solving process where the learner infers the relationships between individual components of the narrative. He suggests that the goal of these inferences is to establish and maintain a certain level of causal coherence when creating representations of the narrative. If the learner does not make these connections, the narrative will appear to be a world of disjointed components of information, making it difficult to understand the character's motives and identify the narrative's themes (van den Broek et al., 1996). Furthermore, this can interfere with connecting the relationships between events in the narrative (Trabasso et al., 1982). However, readers have inferencing mechanisms that they utilize to facilitate the comprehension of the narrative (Graesser, et al., 1994).

According to Van Kleeck (2008), an essential type of inference that facilitates narrative comprehension is casual inferencing. She suggests that these causal links occur among different elements of the story such as during the initiating event or problem, the characters' responses, their agenda, their attempts to resolve or address the issue, and the consequences of those actions. Trabasso (1980) and Loukusa and Moilanen (2009) suggest, one must engage in inferential thinking to recognize these connections, piece them together, and generate meaning information. As cited in Trabasso (1980), Warren, Nicholas, and Trabasso (1979) further argue that causal relations can take on different forms such as: (a) motivational relations, (b) physical relations, (c) psychological relations, and (d) enabling relations.

Motivational relations refers to the connections of the agent's intentions or needs to the actions the agent engages in. Physical relations demonstrate how one physical event leads to the

next event. Psychological relations demonstrate how an event brings out an emotion, goal, desire, or other internal states in characters; and enabling relations show how one state or event can fulfill preconditions that lead to another event. These representations demonstrate a network within the narrative (van den Broek, et al., 1996). Engaging in this level of thinking helps the learner to produce a variety of operations such as retelling the narrative, summarizing, identifying themes and main ideas, understanding causes of events, paraphrasing, and taking on different perspectives (Trabasso, 1980).

The Learner's Knowledge Base: The Foundation of Narrative Comprehension

According to Kintsch (1988), and Kintsch and van Dijk (1978) part of what makes reading such a sophisticated process is how well the reader is able to make meaning from ideas embedded in the text. In a narrative, although there may be many ideas that are connected in some sort of complex network, the ideas at the macrostructure level are housed in conventional slots, such as the setting, complication, and resolution. These researchers suggest that it is the macrostructure combined with the microstructures (e.g., propositions) that form the text-base that the reader then uses to create a situation model by combining the text-base with their knowledge-base to generate meaning, according to their Construction-Integration Theory. However, depending on the interpreter's interest, goals, background knowledge, and perceived value of the narrative, each interpreter will form a unique situation-model for a given text.

Given the need to make connections between new ideas, events, and prior experiences, background knowledge plays a fundamental role in understanding narratives (Bruner, 1991; Kintsch, 1988; Kintsch & van Dijk, 1978; Loukusa & Moilanen, 2009; Trabasso, 1980; van den Broek, 1990; Van Kleeck, 2008). One's knowledge-base consists of both specific and generic knowledge structures (Graesser et al., 1994). Graesser and co-investigators (1994) describe specific knowledge structures as memories of representation of particular experiences, memories of other narratives, and previous excerpts of the narrative, whereas generic knowledge structures include: (a) schemata (Mandler, 1984), (b) scripts (Schank & Abelson, 1975), (c) stereotypes (Wyer & Gordon, 1984) and other packets of generic knowledge. Furthermore, when these scripts are very familiar to the learner, they help the learner understand explicit events and states (Graesser, et al., 1994). Trabasso (1980) suggests that the learners' knowledge-base, which includes insights from their socio-cultural background and experiences, is the foundation for comprehension. van den Broek (1990) argues more specifically that learners use their background knowledge about psychological and physical causality to find connections between causes and consequences of events in a narrative. Van Kleeck (2008) makes an additional claim, that background knowledge is also essential for understanding what is not explicitly stated. The question then becomes, how does the learner integrate their knowledge-base with the information provided in a narrative to gain a coherent understanding?

Figure 1 depicts the process of Kintsch's (1988) theory of a situation-model where the reader integrates his or her world knowledge with the text-base when using narrative and supporting visuals. The process begins with context; essentially the reader is first situated by the discourse context (e.g., motive for reading the story). For example, the student might be reading for a class, for pleasure, out of curiosity, or a myriad of other reasons, but in any case, they are situated by those reasons. The reader then engages in the construction process, where they build a text-base. In order to accomplish this, the learner forms concepts directly corresponding to the linguistic input (P) from the narrative. This then elicits new ideas. Some of these ideas are based in their world-knowledge (K), others are based on the text-base, including macro-propositions (MP) such when the reader hears or reads the climax of the narrative (see Figure 1).

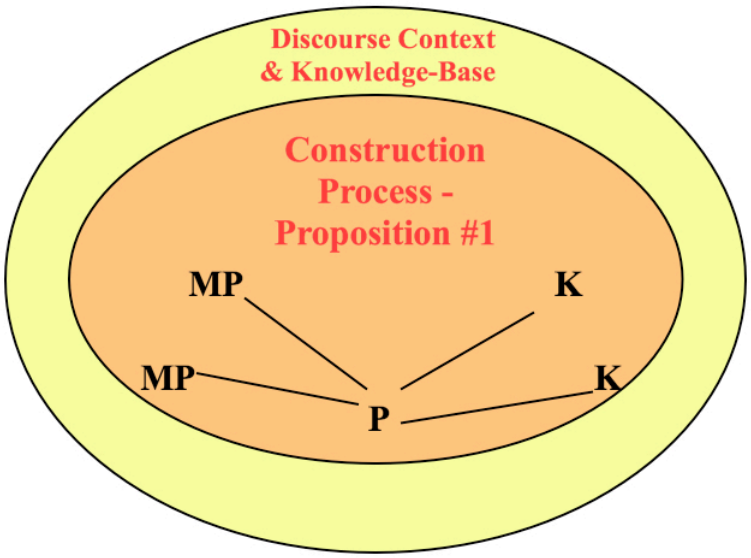

Figure 1. Text-base construction process. This figure demonstrates the ideas evoked by the proposition.

As shown in Figure 2, readers proceed through the integration process, where they use their world-knowledge to constrain only relevant ideas, as it pertains to the linguistic input of the narrative. Essentially, the integration process strengthens the contextually appropriate elements related to the narrative, and inhibit inappropriate ones leading to a situation model of the narrative thus far, in this example the situation model is represented by *Pk-mp*.

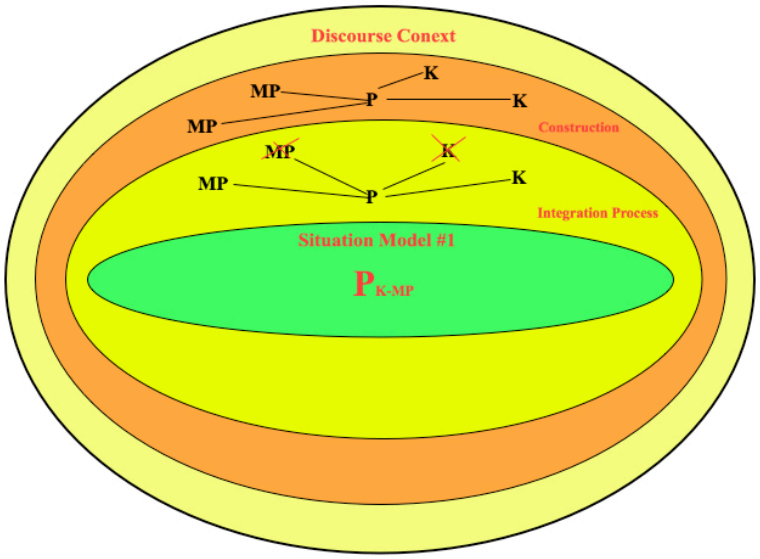

Figure 2. Integration process. This figure demonstrates the constraining process of evoked ideas.

Figure 3 shows how integration process continues to update itself as the reader comes across new information in the narrative, constantly updating their situation model of what is taking place in the narrative

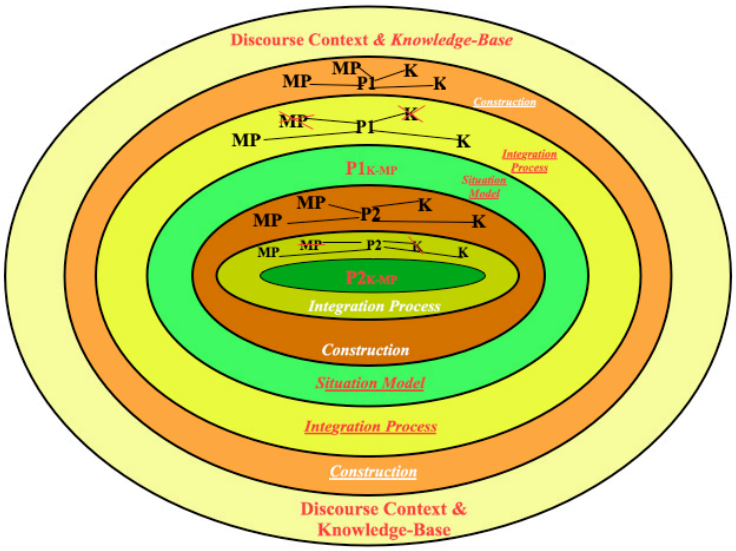

Figure 3. Updated situation model. This figure demonstrates the iterative process creation of a situation model.

Inferential Thinking in the Context of Narrative Comprehension

Question-answer-relations. Pearson and Johnson (1978) published a book exploring the nature of questions, diving into their relationship with the text and the reader. They argue that questions warrant our attention because of their widespread use, their vitality during discussion activities, and the ability to tap into the construct of reading comprehension. Pearson and Johnson suggest that questions cannot be confined to a category (e.g., text-explicit, text-implicit, & script-implicit QARs), without examining their relationship with the information provided in the text-base, and the information provided by the respondent's world-knowledge. They came up with a theory for three categories of reasoning used in reading comprehension that include: (a) text-explicit QAR (i.e., where the answer in on the page and the question-answer relation is explicit.); (b) text-implicit QAR (i.e., where the answer in on the page, but the question-answer relation is implicit. Meaning that the question and answer are derivable from the text, but there is no logical or grammatical cue tying the question to the answer, and the answer given is plausible in light of the question); and (c) script-implicit QAR (i.e., the question answer relation is based on the inserted world-knowledge, and not found on the page).

It is also important to consider the notion, that although we may try and categorize these QAR as question types, in an open response format, the respondent may say something unexpected. For example, imagine a narrative where two children have just met, and one offers the other their toy to play with. The teacher then asks, "*What did the child offer the other child?*" One may be expecting a text-explicit QAR (e.g., "*h*e offered the toy") but another student might say, "*he offered friendship.*" These two responses clearly differ in terms of their source of information. In the first response, the answer was a detail explicitly provided in the story,

suggesting a text-explicit QAR. The second response; however, is indicative of the respondent's world knowledge—something about this narrative indicates someone is trying to make friends with someone else. Perhaps the respondent inferred that offering a toy represents a clear intention of making a friend, representing a script-implicit QAR.

Other scholars have built upon Pearson and Johnson's (1978) inferential thinking model. Warren, et al., (1979) posit two macrocategories of inferences that help learners gain a coherent understanding of a narrative, which are called *text-connecting* and *slot-filling inferences.* Text connecting inferences are demonstrated when, "he/she either finds semantic and/or logical relations between propositions or events which are expressed in the narrative…" (Trabasso, 1980, p.1). Whereas slot-filling inferences are demonstrated when, "he/she fills in missing information which is necessary to making such connections between events (Trabasso, 1980, p.1).

Nuske and Bavin (2011) also suggest a similar set of inferences called *propositional inferences and script inferences.*

> "Propositional inferences are based on logical relations between story statements. The underlying structure of these inferences is based on formal deduction whereby two premises are given, from which a logical conclusion is drawn. While propositional inferences rely relatively more on local processing, as opposed to the integration of previously acquired knowledge…script-inferences require global processing of event schemas" (Nuske & Bavin, 2011, p.110).

Event Schemas are mental representations of how events tend to play out in real-life (Nuske & Bavin, 2011). Cain, Oakhill, Barnes, and Bryant (2001) suggest a similar set of inferences called *coherence inferences*, which are essential for creating links between premises in a text, and *elaborative inferences*, which connect the text-base with the learner's knowledge-base.

Based on the definitions provided, text-implicit QAR (Pearson & Johnson, 1978), propositional-inferences (Nuske & Bavin, 2011), coherence inferences (Cain, et al., 2001), and text-connecting inferences (Warren et al., 1979), rely relatively more on local processing, and are essential for local coherence, as text-implicit QAR revolves around the understanding of the relationships between details within the text-base. Whereas script-implicit QAR (Pearson & Johnson, 1978), slot-filling inferences (Warren et al., 1979), script-inferences (Nuske & Bavin, 2011), and elaborative inferences (Cain, et al., 2001) rely more on global processing, as script-implicit QAR relies on the integration of one's knowledge-base with the text-base, allowing for relatively more global coherence.

Evaluative, logical and informational relations. In 1979, Warren and his colleagues argued for another way to classify inferences that are derived from considering relations among ideas: logical, informational, and evaluative relations. Logical relations are connections between events that involve causes, motivations, and conditions that allow events to happen, and are explanatory in nature. These things drive actions and events in stories. One particular type of logical inferences they argue for is called motivational inferences. Motivational inferences involve inferring why an agent engaged in an intentional action. These tend to privilege why and how questions. Informational relations include making inferences about nominalizations: people, objects, instruments, times, places, and are often related to who, where, what and when questions. Informational inferences are divided into two subcategories: referential (i.e., specifies the related antecedents to a given action and are used to clarify the roles of people and objects) and spatio-temporal (i.e., space and time). The third type of inferences are evaluative. These

inferences apply notions of significance, morality, themes, and lessons within the story, and are highly sensitive and related to the reader's world knowledge.

Towards a merging of relations. In 1992, Chikalanga proposed a levels of comprehension theory that combined Pearson and Johnson's (1978) and Warren and colleagues' (1979) inferential thinking models. Essentially, Chikalanga argued that depending on the relationship of the information provided by the text-base and the reader's world-knowledge, logica*l* and informational inferences could either be text-based or script-based. (See Chikalanga, 1992) Graesser and his colleagues (1994) suggested a set of knowledge-based inference*s,* which are generated from using the readers world-knowledge and the text-base, and that operate at the situation-model level, rather than at the surface-code (i.e., wording and syntax), or text-base (i.e., explicit propositions, including inferences for text cohesion) levels. They further posit the notion that this ability to infer is also essential for deeper comprehension. Deeper comprehension is demonstrated when the reader creates ideas for causes and motives that explain why certain events and actions happen, and when the reader infers the main idea or global message of the text. They posit 13 classes of knowledge-based inferences in the context of narrative comprehension (see Graesser, et al., 1994). They suggest these special classes of inferences utilize both the text-base and the learner's knowledge-base to varying degrees. Accordingly, "knowledge-based inference*s* are constructed when background knowledge structures in long-term memory (LTM) are activated, and a subset of this information is encoded in the meaning representation of the text" (p. 374). They further suggest that these knowledge-based inferences aid in understanding the goals and plans that motivate a character's actions, the character's knowledge and beliefs, character traits, emotions, the causes for an event, properties of objects, spatial relationships among entities, predictions about future events, referents of nouns and pronouns, and attitudes of the author.

Graesser and co-investigators (1994) suggest that referential (e.g., a word or phrase that is referentially tied to a previous element or constituent in the text (i.e., explicit or inferred), case structure role assignment (e.g., an explicit noun phrase that is assigned to a particular case structure role, such as, agent, recipient, object, location, time), and causal-antecedent inferences (i.e., the inference is on a causal chain, or bridge, between the current explicit action, event, or state and the previous passage context) are essential in establishing local coherence. Superordinate goal (i.e., the inference is a goal that motivates an agents intentional action), thematic (i.e., the main point or moral of the text), and character emotional reaction inferences (i.e., the inference is an emotion experienced by a character caused by or in response to an event or action) are needed to establish global coherence. Thus, when evaluating why a character performed an intentional action, one can engage in inferences used for local and global coherence since these responses tend to include their superordinate goal and the causal-antecedent*s* that trigger these goals.

Some of Graesser and colleagues' (1994) knowledge-base inferences can theoretically be mapped onto Warren and colleagues' (1979) motivational inferences, specifically causal antecedent, superordinate goal, thematic, character emotional reaction, causal consequence, and state inferences. When asking a motivational inference question, such as "why did he steal the car?" one could answer based on the character's superordinate goals (e.g., "he wanted to get to the store"—the desire to go to the store motivated the action), character emotional reaction ("he was feeling angry" is his emotion was the motivation for his action), causal-antecedent ("someone dared him to do it right before"—the event prior was the motivation for the action), state ("he believed he could succeed" is his belief was the motivation for the action), casual-

consequence ("his friends would celebrate him after" is the forecasted consequential outcome of the event in question was the motivation for his action), or even a thematic inference ("because desperate people do desperate things" is the moral, lesson or principle was the motivation for the agent's action). Evaluative inferences could be answered based on thematic inferences (Greasser et al., 1994).

The Role of Coherence in Meaning Making

Graesser and co-investigators (1994) suggest that local coherence refers to the structures and process that organize the elements, constituents, and referents of adjacent clauses in the narrative (i.e., linking information together within the narrative's text-base and being able to recite those connected events); global coherence is established when the individual takes local chunks of information and organizes and connects them in such a way that makes higher order representations (i.e., linking the information together to generate the theme of the narrative). Long and Chong (2001) also describe local coherence as involving the process of mapping each proposition to other propositions currently active in working memory, typically relating to neighboring sentences. Global coherence on the other hand involves mapping incoming propositions to information encountered earlier in the text (i.e., beyond the span of working memory) and to relevant world knowledge.

However, other scholars have interpreted coherence differently, but thematically similar. For example, Hobbs (1979) describes the degree of coherence at the discourse level where there are successive utterances about the same general topic. In this case, coherence is a characteristic of the text, and its degree of consistency as it relates to those ideas. Wright, Koutsoftas, Capilouto, and Fergadiotis (2014) have similar perspectives, but look at coherence in terms of local and global. Where global coherence refers to how the unit of discourse (e.g., utterance, proposition, sentence) maintain the overall topic; whereas local coherence refers to how the information provided by one unit of discourse relates to the content of the neighboring units. In this case, the degree of relatedness, or congruence, lies in the relationship between closer and distal topics of information. This perspective is similar to Glosser and Deser (1992) who define global coherence as the degree to which the overall topic was maintained. However, Ng and Mooney (1990) look at coherence in terms of degree of consistency, in this case the degree of consistency is in regard to known facts. If one were to say the sky is purple, this would be incoherent, as it does not overlap with known facts. A similar view of coherence comes from McAdams (2006). McAdams (2006) describes something as incoherent when there is not a level of congruence, or overlap, with the information provided and the way the world works, how human beings typically act, think, and feel. Essentially, incoherence occurs when structural norms have been violated—in short when the information is anomalous. But the perception of anomaly, is moderated by expectations about the genre and other matters. For example, in response to a fictional story about elves and wizards—if the reader has a schema for fantasy fiction—relations that would be considered anomalous and incoherent for non-fiction might be highly coherent for fantasy fiction.

Thus, coherence thematically can be seen as the degree to which there is overlap or congruence between ideas in the text and ideas in our world knowledge. Sometimes this may be situated based on proximity of ideas and how distal the relationships are within the characteristics of the text. At other times it is the degree of representation and how well those representations hold against the test of criteria used to evaluate that degree of coherence.

Narratives have been discussed in terms of properties of the text, the role of world-knowledge, inferential thinking, and coherence. These all represent different vantage points for

how one makes meaning out of narratives. However, how do these theoretical positions relate to different processing styles, particularly local vs global processing dispositions, in the context of narrative comprehension? This question is especially applicable for those on the autism spectrum. In order to investigate this question, I will explore a prominent social-cognitive theory, central coherence theory (CCT; Frith, 2003; Frith & Happe, 1994; Happe & Frith, 2006).

Theoretical Underpinnings of Autism and Narrative Comprehension[1]

Central Coherence Theory

CCT has two realizations, weak and strong. Weak CCT is based on the idea that the individual has a detail-oriented processing bias, such as individuals with autism (Frith, 2003; Frith & Happe, 1994; Happe & Frith, 2006). For example, Frith (1989) suggests that if someone has strong CCT then that person would have fewer relative challenges at integrating local information to generate relatively larger representations. Global coherence is different from chaining events, since chaining events only requires the individual to piece together the event at hand with the adjacent one, rather than having to understand the whole (Frith, 2003; Frith & Happe, 1994; Happe & Frith, 2006). Happe and Frith (2006) further suggest that this should be seen as a processing disposition rather than a deficit. It is not to say that individuals with autism cannot perform global tasks at all, rather they have a tendency to prefer local over global tasks but are able to perform global tasks when they are primed.

Schlooz and Hulstijn (2014) found that individuals with autism demonstrate strengths in local processing through the Embedded Figures Test (EFT; Witkin, Oltman, Raskin, & Karp, 1971). The study included participants from the ages of 9-14 years. They divided the autism group (n=36) into two subgroups, one group labeled Autistic disorder (n=15) and one group labeled *Pervasive Developmental Disorder* (PPD; n=21), which included individuals with Asperger Syndrome. Participants were excluded if their mean IQ was below 75 based on the Dutch Version of the Wechsler Intelligence Scale for Children–Revised (Wechsler, 1974). This way the groups were more homogenous within the heterogeneous population of autism. The control group was comprised of typically developing participants (n=46). The participants were given the children's EFT and the adult EFT. The idea behind each test is for the participant to locate a smaller target shape within a larger picture and trace it in the picture to identify it. The researchers also measured accuracy and response time.

Results from this study indicate that there were no statistically significant group differences in performance on the children's' EFT in terms of accuracy and response times. In terms of the adult EFT, the Autistic and control group differed significantly in terms of accuracy, but not reaction times. The Autistic group scored the highest on the adult EFT in terms of accuracy with the PDD group scoring in-between the Autistic and control group on the adult EFT. The PDD group did not perform significantly higher than the control group. In addition, it seems that the children's EFT was easier to complete for all groups since reaction times for the children's EFT were also about half of the measured reaction times for the adult EFT. The adult EFT was conducted with the participants in order to avoid ceiling effects.

Several empirical studies offer further insight into the dispositions and challenges in narrative comprehension for individuals with autism. Nuske and Bavin (2011) sought to measure narrative comprehension skills in individuals with high-functioning autism (HFA), similar to what would be considered Asperger, relative to their typically developing peers (i.e., control

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[1] I will be using different terminology for autism based on the various diagnostic tools used at the time (prior to DSM-V, 2013)

group). They recruited 28 children comprised in two groups: 14 children with HFA (13 males, 1 female) ages 4–7 years, and 14 typically developing children (7 males, 7 females) ages 4-5 years. In this study they gave a series of tasks that were divided into two categories, those that are relatively situated in local coherence, and tasks that orient themselves relatively more towards global coherence.

The tasks which oriented themselves towards local coherence included: block design tasks (e.g., recreate the block design), detail questions (e.g., literal questions about a passage), and propositional inference questions (e.g., inferring based on logical relations between story statements). The tasks that orient themselves towards global coherence included: main idea questions (e.g., evaluative questions about the passage as a whole), and script-inference questions (e.g., questions about the passage that require the integration of world knowledge).

In terms of their results, there was no inverse correlation between local coherence tasks (e.g., block design, detail questions, and propositional inferences) and performance on global coherence tasks (e.g., main idea, script inferences). From this, they posit that one's processing style is not necessarily compensatory, where relative strengths in one skill makes up for the other. In terms of script-inferences, the HFA group performed statistically significantly lower than the typically developing control group. This may be because these tasks require the individual to make inferences based on event scripts by integrating existing knowledge of events with information in the narrative, such as context. But there was not a significant difference between the propositional inferences, which are based on local coherence, and there was no correlation for either group between detail comprehension questions or block design performance, which they hypothesized as two local coherence tasks. There was however a correlation between the block-design assessment and propositional inference tasks, suggesting a possible connection between certain types of local coherence tasks.

In terms of the comprehension tasks, there was no statistically significant difference in performance on main idea tasks between the two groups. However, the HFA group could have been primed by the title of these stories. This would be consistent with Happe and Frith (2006) who noted that if individuals with autism are primed for global processing tasks, they have more opportunity to perform well. For the HFA group in Nuske and Bavin's (2011) study there was no correlation between main idea questions and any other question or inferential question task. But for the typically developing group, *main idea* questions were correlated with scores on the *inference question tasks* and *detail questions*. This suggests that, since both groups performed statistically similar on the *main idea tasks*, yet there were different correlations between the two groups performances on other tasks, it is possible that individuals with autism and typically developing individuals process information differently to arrive at the same conclusions.
In addition, based on the previously mentioned study by Martin and McDonald (2004), participants put together two different puzzles, one with a coherent picture, and one without an image. The control group performed faster on the puzzle that had a coherent picture than one without. This suggests that they may have been using the context (e.g., development of the image), which relies on relatively more *global processing* skills, to infer what the picture was going to be and sped up when putting together the puzzle. However, for the Asperger Syndrome group, they performed at similar times on both types of puzzles, suggesting that they were not necessarily using the context of the puzzle to make predictive inferences of where the following pieces should go. This further supports the idea of a *local processing bias* and *weak central coherence* (Frith, 2003; Frith & Happe, 1994; Happe & Frith, 2006).

Autism and Visual Integration

Although researchers have demonstrated differences between populations (e.g., autistic vs. typical developing peers) in the context of narrative comprehension, particularly the notion of individuals with autism having a local processing bias and the challenges that can come with it, these demonstrated differences are largely influenced by the type of task required. In a meta-analysis conducted by Van der Hallen, et al., (2015) they investigated local-global visual processing differences between individuals with autism and their typically developing peers, through reviewing and comparing a wide range of studies (n=56). The rationale for this study was to investigate the consistency in outcome measures across studies, based on tasks that relate to global and local processing, due to the notion that most studies execute their experiments using a wide range of participant groups and stimuli, which have different task demands.
The studies chosen for the Van der Hallen et al., (2015) meta-analysis were divided into eight categories—depending on the task of the study—block design, categorization, drawing, embedded figures, hierarchical figures, visual illusions, and visual search. Overall, comparing both groups (e.g., autism vs. typically developing) they found similar performance for local visual processing tasks, and an overall relatively lower performance on the global processing tasks for individuals with autism. However, the authors posit that these results do not consider the impact of irrelevant information presented in the stimuli when asking the participants to engage in the task at hand. Using the embedded figures test, as an example, when asked to identify a smaller target shape within a larger shape, the larger shape serves as a global distractor (e.g., irrelevant information) from the smaller shapes. Alternatively, if the participant with autism were to look for a larger shape, with smaller shapes within the larger shape, then the smaller shapes would serve as a local distractor for the larger shape.

The researchers divided the total number of studies collected for the meta-analysis into four categories: non-conflicting local tasks (L-L), local task with conflicting global stimuli (L-G), non-conflicting global tasks (G-G), and global task with conflicting local stimuli (G-L). They found differences in performance between the two groups (autistic vs. typically developing) in one of these conditions. Specifically, they found a diminished performance for tasks that required global processing at the same time that task irrelevant information (e.g., inconsistent local information) is presented (G-L). However, for the non-conflicting local task (i.e., the local task with the conflicting global stimuli, or the non-conflicting global task) participants with autism performed comparably to their neurotypical peers. They argue that instead of seeing individuals with autism as having an overall diminished performance on global visual processing tasks, that they have a more default processing style that is relatively more locally oriented.

The researchers also divided the studies collected for the meta-analysis based on outcome measures, specifically studies that used response time as an outcome measure compared to accuracy. When using response time as an outcome measure, they found significant differences in performance with individuals with autism being significantly slower. However, when focusing on accuracy, they did not find significant differences between these two populations. These findings further suggest that rather than having a deficit in global processing per say, individuals with autism may simply need more time to process the information.

The authors further posit that global and local perceptual processing skills are not necessarily one continuum, from local to global, but rather two separate skill sets with their own developmental trajectory. If they were one continuum, then strengths in local tasks would take away from strengths in global tasks, a sort of compensatory model. However, this was not the case in this study, which is also aligned with notions posited by Happe and Booth (2008).

Theoretical Summary of CCT

Central-Coherence theory (Frith, 2003; Frith & Happe, 1994; Happe & Frith, 2006) can help explain the challenges individuals with autism face when comprehending narratives. If one struggles with the integrative skills necessary to comprehensively understand the perspectives of others and how to respond based on the mental state of others, then how is that individual supposed to comprehensibly understand characters in a narrative? In addition, it may prove to be extremely challenging to understand a narrative if context information is being misinterpreted, due to incongruences between what was expected and what actually happened, leading to incoherence. For example, when reading about people, tone, mood, sarcasm, and other subtle nuances embedded within the context, the understanding of words and actions are likely to be variable, as they do not have singular meanings or interpretations. In fact, there may be many ways to interpret a smile given by a character beyond the character feeling happy. These misinterpretations can make it more challenging for an individual with autism to predict and understand the narrative in the way it was intended to be understood.

Furthermore, since narratives involve characters, there is context associated with those characters' actions, motives, and personalities. To be able to understand context one must be able to integrate the individual components to gain a deeper understanding. However, if one has a local processing bias, he may fixate on details and lose sight of the larger meaning; further contributing to the misinterpretation of the author's intended message. It may also lead to confusion as to why certain characters perform certain tasks; further complicating how an individual understands why a certain event is happening. Additionally, if one has relative challenges integrating information at a more global level, then how can they derive themes, morals, and main ideas from the narrative effectively? These are valuable literary elements that educators use to foster social skills, critical thinking, writing, and other literacy skills.

Challenges in understanding the behaviors and perceptions of others, relative to social situations, can impact areas of instruction that contains thoughts, feelings, and emotions of characters. This may lead to challenges in sensitivity to the causal structure of narratives (Constable, Grossi, Moniz, & Ryan, 2013). If individuals with autism have relative difficulties interpreting social information and making appropriate inference then following the causal thread of narratives, especially when characters' motives for actions are involved, poses a further challenge. Lynch et al., (200) suggested that the more causal links embedded within text, the more the individual with autism will be able to recall. However, if one is misinterpreting aspects of the text, or having trouble making causal connections between events and characters in the narrative, then the more causal links there are, the more ambiguous the text becomes. All of these factors can influence the mental representations the learner generates from the narrative context, leading to misinterpretations and inaccurate predictions. Furthermore, if one has a local processing bias, then that learner may have trouble engaging in global-like evaluative comprehension tasks such as theme, moral, and main ideas.

Considering the idea of difference vs. deficit in terms of global processing, and the notion of processing bias, if one has a local processing bias from birth, then this could impact how he interacts and makes meaning from the world around him. Klin, Jones, Schultz, and Volkmar (2003) suggest an alternative framework—enactive mind theory—that is oriented towards an individuals' predisposition to gravitate towards relatively more salient stimuli, to differentiate what is more relevant to them, and to highlight the primary role of certain predispositions that motivate certain responses to social stimuli. Essentially, enactive mind theory suggests that

social development is a result of social action. Jones and Klin (2013) argue for appreciating the open nature of social adaptation, suggesting that there is a need to consider the unique disposition towards different environmental elements depending on their perceptions, desires, and goals. Thus, one's experience informs how these factors are understood and acted upon.

This theory incorporates a developmental orientation to change, that as the child develops, they are constantly scanning for salient aspects of the world, especially if there is a survival component to it. As the child is interacting with the world and gaining experiences, this theory suggests that the events experienced and knowledge gained have a cascading effect on development, where action and thought influence each other and thus cannot be disentangled (Jones & Klin, 2013; Klin et al., 2003). For example, Klin, Gorrindo, Ramsay, and Jones (2009) found that at 2-years old, toddlers with autism more often oriented towards non-social contingences, as opposed to biological motion. Thus, this disposition for non-social orientation can impact their engagement in the world. Furthermore, if one has a disposition to the local level than to the global level, she will further develop local processing skill sets and have less practice utilizing global processing skill sets. Leading to future challenges using global processing skill sets later in life; particularly when social demands increase. These taken together help explain the cascading effect of having a processing bias and how it relates to social cognition in the context of narrative comprehension.

The Illuminating Qualities of Comics

Overall, depending on the task and outcome measures, individuals on the autism spectrum demonstrate different strengths and challenges when it comes to narrative comprehension. So, what can educators do to help this population better access narratives? Multimodal Visual narratives, such as comics, may be an alternative source of supplemental support (Gray, 1994; Rozema, 2015). Comics, like traditional text, require the reader to make inferences in order to generate meaning, which makes the reader a sort of co-author of the text (Low, 2012). In addition, comics can demonstrate various topics and concepts, meaning comics can serve as teaching material across different disciplines and throughout the curriculum (Pantaleo, 2013).

Comics can also be an excellent tool for enhancing students' literacy skills by incorporating the visual literacy abilities of the reader (McVicker, 2007). When students are reading a large body of text, they are required to imagine all the descriptive details to construct a representation in their head. Comics can aid in this process by providing further visual support to anchor these details (McVicker, 2007).

Multimodal formats, such as comics, may also be more conducive for engaging in higher order thinking for those on the autism spectrum (Rozema, 2015). Specifically, Gaffrey, Kleinhans, Haist, Akshoomoff, Campbell, Courchesne, and Muller, (2007) found that there was significantly more activity in the part of brain responsible for imagery in participants with autism as compared to a typically-developing control group. When individuals with autism were categorizing text, it was as though they were thinking in pictures. In addition, Kamio and Toichi (2000) found that individuals with autism were better able to access their pictorial semantic system than typical controls compared to verbal semantic system.

Cohn (2007) argues that comics serve as a visual language; much like an information system tied by grammatical structure. He continues to posit that a cognitive system becomes language when a collection of mental patterns, which organize the expression of concepts through a sensory input, becomes culturally understood by a whole community. Furthermore, it is argued that visual narratives such as comics help make meaning more retrievable or

transparent by utilizing over pronounced faces and characterized emotions, leading to less ambiguous social and emotional input (Rozema, 2015). With comics comes visual vocabulary (e.g., dashed lines indicating movement or visual morphemes representing over pronounced sweat drops falling from face indicating nervousness), and grammar (e.g., macro propositions such as establishment, initial, peak, and release). In fact, Cohn, Paczynski, Jackendoff, Holcomb, and Kuperber, (2012) demonstrated that people are intuitively sensitive and attuned to these grammatically structured features in comics when comprehending them.

These graphic emblems also represent invisible qualities such as emotion or motion. Thus, it makes the latent more transparent. In addition, in comics, different types of panels can promote comprehension such as micro panels (e.g., one character in the frame), macro (e.g., multiple characters in the frame), and refiner panels (e.g., close ups of previous frames in a specific area). Furthermore, the outline of the frames can be manipulated to demonstrate context of the event (Rozema, 2015). This practice could serve as a natural scaffold for managing agent overload (e.g., too many characters to manage), time, and understanding the sequence and significance of events, since the reader has the ability to manipulate time. Essentially, readers can control time's flow by looking at the past, present, and future on the same page at the same time, thus, time is explicit and malleable.

It is important to understand the mechanics of how comics work, and the manner in which they serve as the landscape to build meaning from. Comics are a unique type of visual narrative because there is a sequence and grammar involved across panels that people are hardwired to be sensitive to (Cohn, et al, 2012). This grammar serves as the infrastructure to the micro and macro propositions of a visual narrative, while also at the same time serving as a scaffold to facilitate one's inferential thinking as he makes meaning out of the semiotic nature of comics.

Sequential Image Visual Narrative Grammar

In comics, graphics are placed in individual panels that can be thought of as attention units and considered the basic unit of a visual narrative (Cohn, 2007). Depending on how the panels are drawn, they can demonstrate a character's point of view, different perspectives of events, and demonstrate focus points (Pantaleo, 2013). The narrative structure takes these panels and orders them in such a way that there is a particular pace set, and based on the sequenced panels, readers derive meaning from both the graphics inside of the panels and the events they engage in (Cohn, 2013). In order for a comic to be best understood, there needs to be some type of structure to the sequenced panels known as narrative grammar (Cohn, 2013; Cohn et al., 2012). Narrative grammar, which is also analogous to narrative structure, falls into five primary categories: establisher, initial, prolongation, peak, and release (see table 1).

Cohn (2013) goes on to describe establishers as the first impressions of the scene, set up the characters, and lays the foundation for new information. Initials set the action or event in motion, and typically displays the action that leads to a peak. For example, this can be someone getting ready to run, but not actually running yet. Prolongation can function as the pause, demonstration of trajectory of an event, a tool for suspense, cliffhanger, or anything that delays the peak. Peaks represent the culmination of all the buildup in the graphic narrative and may be demonstrated as a change of state, action carried out, or interruption of event. The release is the result of the peak and serves as the release of tension of the peak; much like a wrap-up or conflict resolution. Figure 4 is a visual representation of the five categories of narrative grammar:

Table 1
Narrative Grammar Definitions

Panel category	Panel definition
Establisher (E)	Sets up an interaction without acting upon it.
Initial (I)	Initiates the tension of the narrative arc.
Prolongation (L)	Marks a medial state of extension, often the trajectory of a path.
Peak (P)	Marks the height of a narrative tension and point of maximal event structure.
Release (R)	Releases the tension of the interaction.

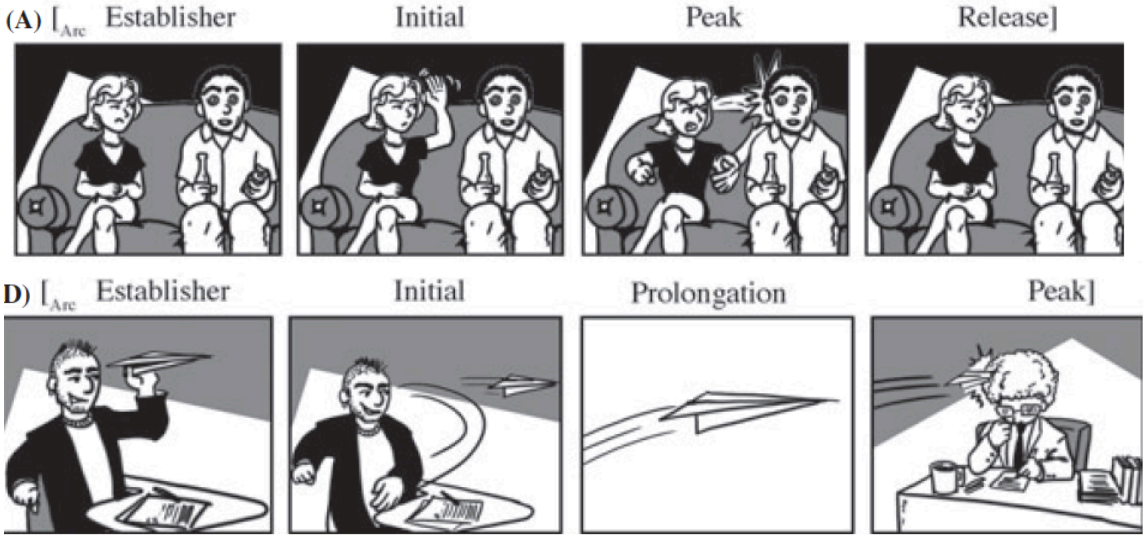

Figure 4. Narrative Grammar Categories. Sample items retrieved from (Cohn, 2013, p 422)

Sequenced Images (Comics) as a Visual Language

When one communicates there are a variety of modalities one can use. These modalities have their own structure rule bound sequences—known as grammar—that form communication, which becomes language (Cohn, 2007). For example, "there is the verbal language of sound, a signed language of body movements, and a visual language of sequential images" (Cohn, 2007, p. 35-36). Units of language come in different forms, such as words and morphemes (Cohn 2007). These units are put together to form some sort of meaning within the syntactic structure. In terms of sequential images, such as comics, the frame or panel that holds the graphic can be seen as a unit of language in the visual language system (Cohn, 2007). In this case syntax is defined as, "a system of rules that govern the ordering and arrangements of units" (Cohn, 2007, p. 36). Thus, in terms of visual syntax of sequenced images, if each panel represents a language unit, then the syntactical sequence is the specific arrangement of these panels to derive meaning.

Although this may position words as analogous to panels, since words can be the syntactic unit of verbal and written language, they are not the same, rather panels represent a similar function in the two parallel systems: visual and verbal language (Cohn, 2007).

One primary characteristic of panels is the idea of a positive or active element or the unit of attention within the graphic (Cohn, 2007, see figure 5).

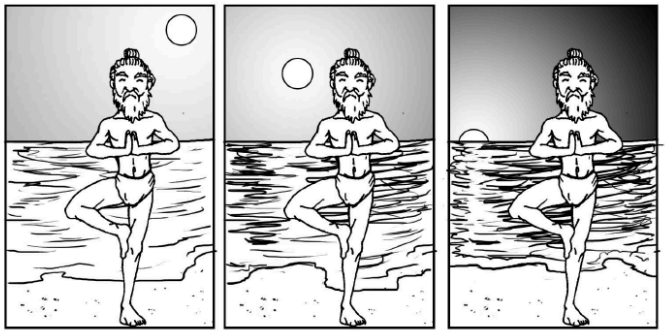

Figure 5. Element Dynamics. The changing state of the active element from Cohn (2007, p. 38) In this case, the sun is the active element—known as grammatical entity—since it is changing and affecting the interpretation of the sequenced images (Cohn, 2007). This is not to say that the man or the background does not give meaning, however, the grammatic entity is the only factor that affects the syntax (i.e, the ordering of the sequenced images; Cohn, 2007).

Cohn (2007, p. 39) displays a Lexical Representational Matrix which demonstrates category of panels based on the amount of grammatic entities there are (see figure 6).

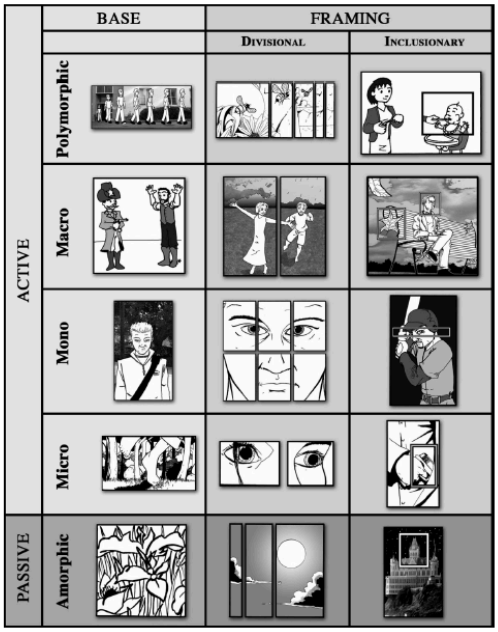

Figure 6. A *lexical representational matrix.* A graphic organizer for panel attributes. The vertical axis demonstrates the progression of panels from full actions, to scenes, to single entity, to less than one entity (i.e., close ups), to no entities. The horizontal axis demonstrates these base distinctions and shows the different panel options to demonstrate them.

Based on the explanation of the matrix from Cohn (2007), table 2 was created to explain this matrix.

Table 2
Adaptive Lexical Representational Matrix

Panel type	Description of panel type
Polymorphic	These panels demonstrate an event. This can be placed into a singular panel, be broken up over a series of panels, or a panel within a panel, through the representation of a single entity at different stages in their depicted action.
Macro	These panels have more than one grammatic entity but represents a scene rather than an event. This can be depicted through one panel, a series of panels, or a panel within a panel.
Mono	These panels only depict one grammatic entity and also represents a scene. This can be demonstrated through a single panel, a series of panels, or a panel within a panel.
Micro	These panels represent a close-up of the grammatic entity. This can be placed into a singular panel, be broken up over a series of panels, or a panel within a panel.
Amorphic	These panels have no active subjects and is typically seen as environmental features or inanimate objects. This can be placed into singular panel, be broken up over a series of panels, or a panel within a panel.

As demonstrated in Figure 7, these panels do not necessarily need to hold singular meanings on their own and can work together to form meaning. For example, there can be scenes that are distinct panels but are fragments of the same environment. This is known as environmental-conjunction (Cohn, 2007). Below is a picture, which demonstrates this from Cohn (2007, pg. 41)

Figure 7. Environmental Conjunction. The components of an environmental conjunction.

First the two mono panels represent two people in the same environment, which is shown in the macro third panel. This shows that panels can be grouped together to form a greater meaning, without overwhelming the reader with too much information in each panel (Cohn, 2007). Within the visual language system, there are also morphological symbols (Cohn, 2007). For example, the picture below represents this from Cohn (2007 p. 48).

Figure 8. Visual grammatic entity. Example of making a static image active from Cohn (2007, p. 48).

The dashed lines attached to the root (person) represent speed, so now the visual demonstrates that the character is moving fast (Cohn, 2007). The lines alone have no meaning unless it is bound to the root (person) which makes this a bound visual morpheme (Cohn 2007). Thought bubbles should also be considered since they have the power to animate anything with thoughts and speech, as seen in figure 9.

Figure 9. Sample illustration of thought bubble attributes from Cohn (2007, pg. 48)

Based on how the text and graphics are blended, the integration of these grammatic elements create a unified semantic meaning (Cohn, 2007). These graphic morphemes can essentially animate anything (Cohn, 2007). An example of a boundless graphic morpheme would the narrators caption box that is not rooted in any individual (Cohn, 2007).

How Can One Comprehend Comics?

Cohn et al., (2013) did an experiment investigating the effects of narrative structure and semantic relatedness when comprehending comics. They provided participants with four sample comics: (a) narrative structure and semantic relatedness (b) semantic relatedness only, (c) structure only, and (d) scrambled (i.e., no semantic relatedness and no structure). Table 3 provides examples of these four conditions in text and comic form (Cohn et al., 2012):

Table 3
Types of Sequences in Comics

Type of Sequence	Text Example
Normal Sequence	Lucy is tossing a baseball in order to hit it
Semantic Only	Out balls gloves throw pitcher bats running safe catch
Structural Only	Fruitless purple desks fly eagerly
Scambled (No structure or Semantic Relatedness)	Ideas order tossing colorless balls

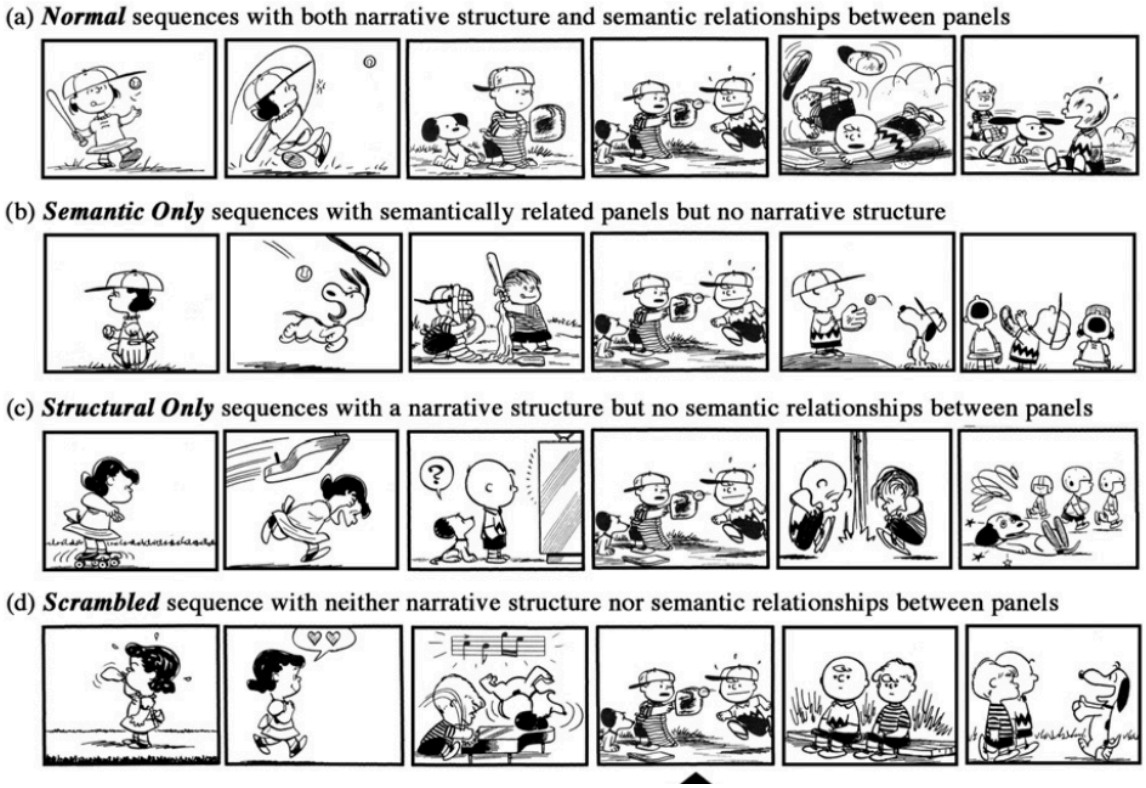

Figure 10. Sample items. Items from Cohn et al., (2012, p. 6)

Using items seen in figure 10, typically-developing participants were asked to identify a target panel and response times were recorded across phases. Target panels were recognized significantly faster in the normal sequences relative to the scrambled sequences and there was no significant difference in response times for the semantic only and structural only sequences. However, response times were significantly faster for the semantic only and structural only relative to the scrambled sequences (Cohn et al., 2012). Most participants were able to recognize the difference between the normal sequence passages than the others, and 46% of the participants were able to recognize the semantic only sequences. Yet, no one was able to recognize the difference between the structure only and the scrambled sequences, but the response times were still significantly faster for the structural only sequences compared to the scrambled sequences (Cohn et al., 2012). This suggests that those participants were able to implicitly pick up and

process the narrative structure implicitly. In addition, Brenna (2013) suggests that graphic novels offer richness in terms of context for teaching reading comprehension and found that students identified learning clues when interpreting the graphic format and mentioned utilizing the style of speech bubbles, text format, panels when generating meaning.

With this evidence, it would seem that comics have the potential to provide more comprehension opportunities than text alone. When students read traditional text, they are only left with the words to construct meaning. When they read a comic, they have the words along with the sequenced graphics support. Low (2012) suggests that reading of comics may allow readers to practice developing imaginative practices that may prove useful when reading other texts without the imaginal support.

Research Question

At a broad conceptual level, the driving question for this study revolves around the most compelling explanation of difficulties students encounter when processing narratives. When individuals, both neurotypical and autistic, engage with narratives, are their challenges better explained by a deficit perspective or an access perspective? In other words, do their challenges resulting from an internal deficit within their repertoire of narrative comprehension processing? Alternatively, is their performance more of an issue of access, in which all three facets of the prevailing construction-integration models (i.e., the reader, text, and context) interact to create situation specific challenges? This line of thinking would suggest that challenges might be modality specific, a possibility that leads to the central research question for this study.

Does the format of a narrative (i.e., comic plus text vs. text-only) impact the likelihood that students, whether autistic or not, will spontaneously integrate their world-knowledge with the facts of a particular narrative when engaging in IIR?

Chapter 2: METHODS

Overview and Design

I adopted the 4-bulding blocks (Wilson, 2005) as the assessment framework for this project. This assessment framework has four components: (a) construct development (b) item design (c) outcome space (i.e., scoring guide), and (d) measurement model. As shown in figure 11, by cycling through, and across, these building blocks in previous pilot studies, this instrument has been calibrated for this study. After describing participants, the following descriptions of materials and outcome measure are products of cycling through these building blocks. Followed by a description of the design, which reflects an item side characteristic (i.e.,s format) and a person side characteristic (e.g., autism diagnosis). The procedures follow and lay out the mechanics and attributes of the models used in the analysis.

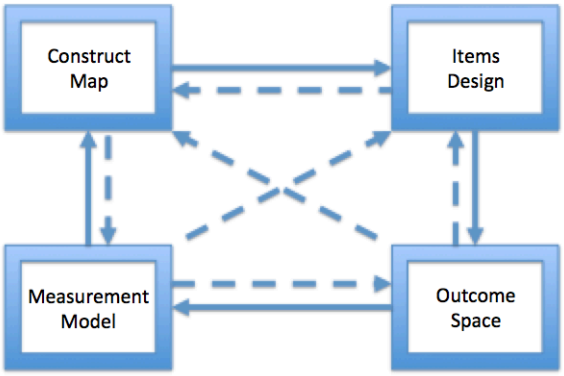

Figure 11. Four-Building Blocks. A demonstration of the iterative process of the assessment frame

Participants

Altogether, 130 participants, ages 11-17 years old, were recruited from San Francisco Bay area schools. Table 4 describes the participants' gender, age, and autism diagnosis.

Table 4
Age and Gender Demographic Table

Gender	Age							
	11	12	13	14	15	16	17	Total
M	2	20	7	6	13	4	12	64
F	4	23	1	1	5	9	10	53
Missing								13
Total	6	43	8	7	18	13	22	130

Materials

The process of developing the comics for the study. Initially in a pilot study, 3-panel comics were used to test items that followed an ex-schema: (a) antecedent, (b) behavior, and (c) consequence. They were based on everyday circumstances that involve helping, sharing, and charity. A sample comic is seen in figure 12. One limitation of these comics was how short they were, and the limited text-based features embedded in the stories to serve as reasons for inference items. They also did not represent a typical story arc that has an exposition, rising action, peak, and resolution, representing more of a story than a social vignette.

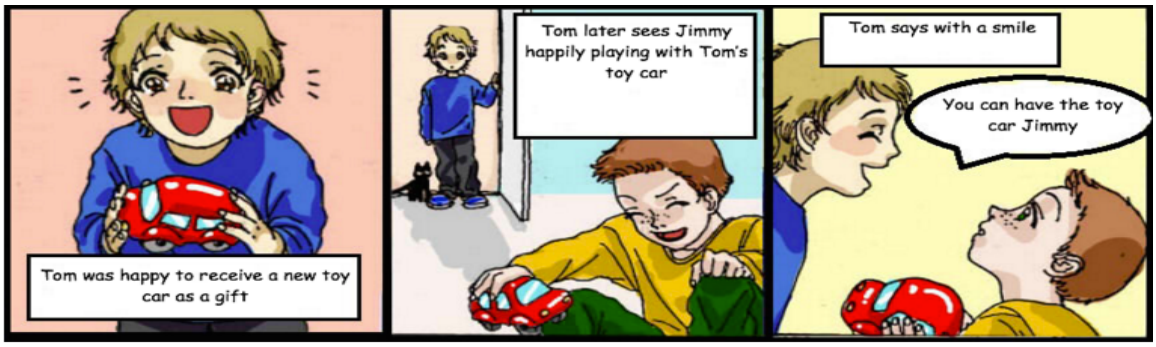

Figure 12. Sample Pilot item. This is a 3-panel narrative representing the theme of sharing.

The current materials. The researcher constructed comics that used visual-narratives for students to read and respond to. These narratives focused on moral and ethical issues involved in human relationships (e.g., friendship, cheating, stealing). These stories were followed by Cohn (2007) narrative grammar theory, where the cohesion of the story was situated by an exposition, initiating acts, peak, and resolution (see figure 13).

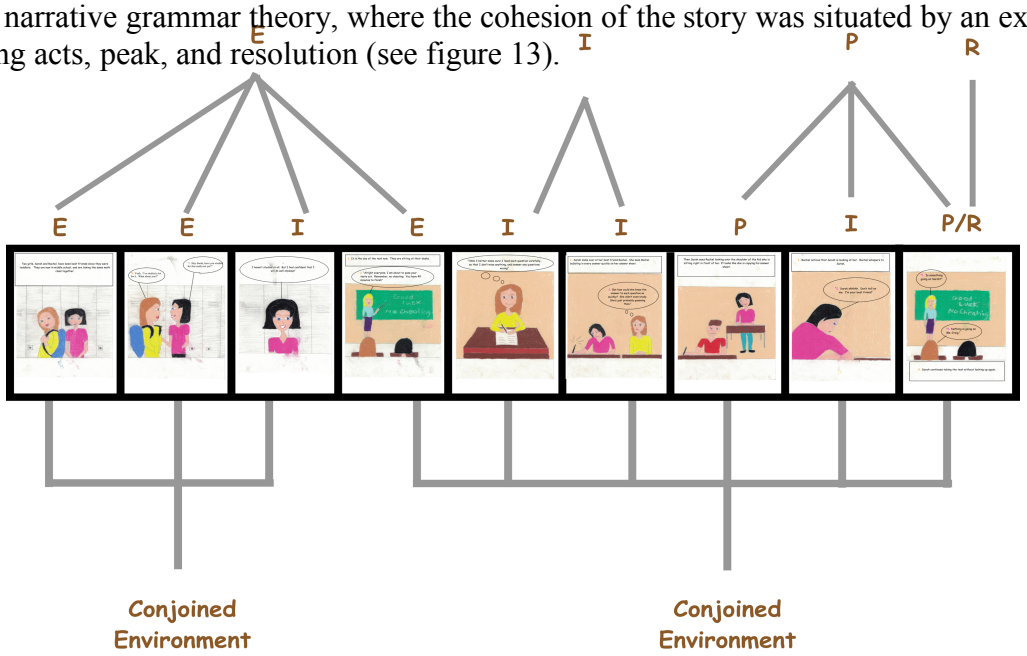

*Figure 13**. Sample item of story (cheating). This item demonstrates the use of Cohn's (2007) visual narrative grammar theory.
*(E—Establisher, I—Initial, P—Peak, R—Release)

Once a visual narrative was completed, it was transformed into a conventional text mode, with the verbal content of the comics reformatted as a conventional story. I constructed the narratives to be at a third-grade level based on Lexile Readability Scores®. The Lexile Readability Score® is expressed as a range and corresponds with grade levels. The lexile range 170L-545L corresponds to a second-grade reading level and 415L-760L with a third-grade level. The Lexile ranges do overlap, suggesting that the lower third-grade level Lexile® score does intersect with an upper second-grade level score. I constructed a total of five narratives, with a comic and text format for each. The average Lexile® score (see Table 5 for the distribution) was

516L. It should be noted that the Lexile® measure is only an estimate of text complexity and its accuracy cannot be guaranteed unless certified by MetaMetrics®. The Lexile® measures were obtained through the online Professional Lexile® Analyzer. As the researcher, I was not trained by MetaMetrics® staff member; even so, I prepared the text for submission to the online Professional Lexile Analyzer® and interpreted the output.

Table 5
Narrative Lexile® Scores

Reading Passages Lexile® Score and Grade Equivalency		
Story	Lexile® Score	Grade Equivalent
Story #1 (Fishing)	480	Upper-second grade/lower-mid third grade
Story #2 (Scocer)	510	Upper-second grade/lower-third grade
Story #3 (Cat)	490	Upper-second grade/lower-third grade
Story #4 (Cheating)	540	Upper-second grade/lower-third grade
Story #5 (Stealing)	560	Upper-second grade/mid-third grade

Note. The questions asked were also assessed for Lexile scores; they appear in Table 6.

Table 6
Narrative Questions Lexile® Scores

Reading Passages Lexile® Score and Grade Equivalency		
Questions for Story#	Lexile Score®	Grade Equivalent
Story #1 (Fishing)	390	Upper-second grade
Story #2 (Soccer)	350	Upper-second grade
Story #3 (Cat)	380	Upper-second grade
Story #4 (Cheating)	370	Upper-second grade
Story #5 (Stealing)	520	Upper-second grade/lower-third grade

Note. The questions fall in the upper-second grade level, with an average Lexile® score of 402L. See appendixes for examples of stories.

Outcome Measure

The proposed Integrated Inferential Reasoning (IIR) construct was used as the outcome measure in order to integrate all five theories (Chikalanga, 1992; Graesser et al., 1994; Kintsch, 1988; Pearson & Johnson, 1978; Warren et al., 1979) involving inference making while reading. Starting at the bottom of the construct map in Figure 14, at level 0, the lowest level of IIR, the response represents an absence of the text-base and world-knowledge. At level 1, called *Text-Implicit*, the response represents the text-based explicitly but not world-knowledge (i.e., associated with local coherence). At level 2, *Script-Implicit*, the respondents world knowledge is explicit and serves as the primary reason given in response to that inference probe, with text-based details supporting it. However, the text-based details are not reasons themselves to the

inference probe, thus, the text-base is implicit (i.e., associated with global coherence). In the highest category, level 3, called *Combination,* the response is both text-implicit and script-implicit—representing a higher degree of global coherence since it is also informed by the local.

In order to address the objectives, I relied on Wilson's (2005) Berkeley Evaluation and Assessment Research Assessment System. In accordance with this method, the researcher started by developing the IIR construct map. Next, items were designed to elicit responses across various levels of the IIR, and an outcome space for classifying responses into IIR levels. Finally, I selected and fit measurement models for answering the research questions. As this is an iterative process, the construct—along with the passages, questions, and outcome categories—have been revised based on pre-pilot data. The Rasch-family item response models were selected due to their unique attributes, specifically their accommodation of polytomous models necessary to scale the multiple levels of response in the IIR's outcome space.

Procedure & Research Design

Phase 1: screening. Participants did not provide their name or identifying information, making this an anonymous procedure. The participants were allowed to use dictation software built into the computer through the accessibility feature (i.e., as you talk the computer types what you say), they were allowed to, and every student was asked if they used this feature at the end of the survey. First, both the autistic students and the neurotypical students were randomly assigned to a task condition, either text-only or text plus comic. Second, all participants in both the text-only and text plus comic format responded to two screening tasks, one in each format, to ensure that all the participants could access a text at a third-grade Lexile® band and respond to multiple-choice, literal-level questions. Third, after the screening task, all students responded to three tasks, four items per task, within the condition in which they were assigned. The order of presentation of tasks was randomized. At the end of each narrative, participants answered a series of literal comprehension questions—approximately one question for every two panels. Then, the sum score approach (e.g., one point for each question) was used, a *t*-test was conducted to compare the mean text comprehension scores for Group A was compared to Group B. A second *t*-test was run to compare comic comprehension scores across groups. *T*-tests were selected to see if there was no significant distinctions between scores across groups and formats, this would suggest that the randomization worked relative to the participants' literal comprehension. This step was done to make sure the passages were not beyond the participants' reading level. For the typical developing sample, groups C and D, the same procedure was used.

Phase 2: task completion. After completing phase 1, participants moved on to phase 2, without any interruption in the testing activity. In phase 2, Group A received three narratives in comic format, Group B received those same three narratives in a text-only format. The order of presentation was randomized. After each narrative, participants answered four inferential-reasoning questions (i.e., *"why did a character engage in an intentional action?*;" "*what made you think of that answer?*;" "*what is the lesson of the story*?;" "*what made you think of that answer?*") in a constructive format (i.e., open response). After those four items, participants answered a series of literal questions, approximately one question for every two panels, in multiple-choice format about that narrative. This was done to demonstrate that the participants had at least a literal understanding of the narrative.

Upon completion of narrative and items, participants inputted their optional demographic information (e.g., age, gender, and comic experience), and answered an exit survey asking if there were any questions the participants didn't understand. Participants responded to all of the comprehension items and requests for demographic information on an electronic form template

More Integration			**Motivational Inference** (Warren et al., 1979): *Why did he give Jimmy the toy car?* Inferences categories: Graesser et al,. 1994.	**Meta-Reasoning**: *What made you think of that answer?*	**Evaluative Inference** (Warren et al., 1979): *What lesson could someone learn from this story?*	**Meta-Reasoning**: *What made you think of that answer?*
	Level 3: Combination Local + Global coherence	**Text-Base** = Explicit (Is a reason for the answer on its own) **Script-Base** = Explicit (Is a reason for the answer on its own)	(**State**) Because Tom is a selfless person **AND** (**Character Emotional Reaction**) giving toys away makes Tom happy.	**(World knowledge + Text-base)** My mom taught me this before **AND** the panel where Tom gave Jimmy the toy.	Sharing will help you make friends (**Thematic**) **AND** when people play with your toys let them have the toy. (**Causal-Antecedent**)	I saw a TV show that talked about friendship (**Memory**) **AND** the line where it says giving makes you a nice person (**Text-Base**).
	Level 2: Script-Implicit *(Pearson & Johnson, 1978)* **Global - Coherence** (Graesser, et al., 1994)	**Script-Base** = Explicit **Text-Base** = Implicit (Not a reason for the answer on its own, but is part of the answer)	**Thematic**: Because *sharing is caring* **Superordinate Goal:** Because Tom wanted to make Jimmy's day great **State:** Tom is a selfless person **Character Emotional Reaction:** Because Tom woke-up feeling happy **Causal Antecedent**: Because while Jimmy was playing with Tom's toy car, he was imagining being a racecar driver. **Causal Consequence**: So Jimmy would not be sad by not having Tom's toy anymore.	**(Memories/World Knowledge)** My mom taught me how to be a friend and share my toys.	**Thematic:** Sharing will help you make friends. **Superordinate Goal**: Always share your toys **State**: Sharing toys is a good thing **Character Emotional Reaction:** Letting others play with your toys makes mothers happy **Causal Antecedent**: When people play with your toys they secretly want to keep them. **Causal Consequence**: When you take away a toy, it will ruin a friendship.	My brother and I did the same thing when playing with toys.
	Level 1: Text-Implicit (Pearson & Johnson, 1978) **Local Coherence** (Graesser, et al., 1994) **Referential Coherence** (Kintsch, 1978)	**Script-Base** = Absent **Text-Base** = Explicit (Is a reason for the answer on its own)	**Thematic**: because you should let others play with your toys. **Superordinate Goal:** because Tom wants to be a nice person. **State:** because It is nice to let others play with your toys **Character Emotional Reaction:** Because Tom giving his toy car to Jimmy makes Tom happy. **Causal Antecedent**: Because Jimmy was playing with Tom's toy car. **Causal Consequence**: So Jimmy would continue to play with Tom's toy car.	**(Text-base)** The panel when Tom gave Jimmy the toy car.	**Thematic**: Letting others play with your toys makes you a nice person. **Superordinate Goal**: Always let others play with your toys. **State**: Tom is a nice guy. **Character Emotional Reaction**: Tom is now a happy kid. **Causal Antecedent**: When others play with your toys, let them. **Causal Consequence**: When you let others play with your toys, it will make your mother proud.	When the comic said that giving makes you a nice person.
Less Integration	**Level 0:** No inference	**Script-Base** & **Text-Base** = Absent	No inference	"I don't know" **OR** irrelevant	"I don't know" **OR** Something irrelevant	"I don't know" **OR** irrelevant

Figure 14. Construct Map for Integrative-Inferential Reasoning (IIR). A taxonomy of inferences. Scenario: Tom woke up wanting to do something nice. His mom always told him that nice people let others have their toys, and that this makes everyone happy. Tom's mom knows this

type of behavior will make her proud. When he went to the kitchen, his mom said, "Jimmy is coming over today!" 5 minutes later Jimmy came over and started playing with Tom's new toy car. Tom then went over to Jimmy and happily said, "You can have the toy car."

using Qualtrics™, with demographic data requested at the end of the survey in order to maintain the integrity of the cognitive tasks.

Data Analysis

Outcome space. The responses to items were scored using a partial credit model. three points were assigned to responses that represented a combination of text-implicit and script-implicit QAR; 2 points were assigned to responses that represented script-implicit QAR; one point was assigned to responses that demonstrated text-implicit QAR and 0 points were assigned to no-inferential reasoning. See construct map in Figure 14 for scoring levels.

Item analysis and scoring metric. The partial credit model (a Rasch-family model) was used to estimate item difficulty and person ability parameters. The Rasch model uses information about the question or item, such as the difficulty level, and the person's proficiency/ability, to estimate the likelihood of responses for each item. Although the term proficiency/ability is being used, that does not necessarily mean achievement in the sense that someone can or cannot do something, rather it means the likelihood to give a particular response. In this context, proficiency refers to the participants' spontaneous integrative inferential disposition located on the IIR construct map (See figure 14), which is the hypothesized construct under investigation.

I used the partial credit model, where item responses fell into more than two categories (Masters, 1988). The formula is as follows below:

$$(\mathrm{X}_{vi} = m \mid \theta_{v,} \delta_{\iota j}) = \frac{exp \sum_{j=0}^{m} \left(\theta_v - \delta_{\iota j}\right)}{\sum_{\mathrm{k}=0}^{x} \exp \sum_{k=0}^{j} \left(\theta_v - \delta_{\iota j}\right)}$$

Based on Wright & Masters (1982), the left side of the equation, $(\mathrm{X}_{vi} = m \mid \theta_v \delta_{\iota j})$ represents the probability, with a proficiency $\theta_{v,}$ of a response X_{vi} in category m rather than any other category on item i given that item i has a set of step difficulties $\delta_{\iota j}$. An item's step difficulty is based on the number of respondents that reach that step for that item. An easy step means a lot of respondents reached that step, and a hard step is when fewer respondents reach that step.

The right side of the equation, $\exp \sum_{j=0}^{m} (\theta_v - \delta_{ij})$ describes the exponential sum of the differences between person θ_v and the step difficulties (δ_{ij}) for item (ι) , acorss all items, for all categories 0 through m. This is then divided by the sum of all the possible numerators across all categories for item i, where x is the total number of categories: $\sum_{\mathrm{k}=0}^{x} \exp \sum_{k=0}^{j} (\theta_v - \delta_{\iota k})$. δ_{ij} can also be seen as the representation of the amount of θ required to respond at or above this category. Once the person's proficiency score and item step difficulty estimate have been established, the partial credit model places the responders ($\theta_{v,}$) and the item steps (δ_{ij}) on one scale, called the logit scale. Each unit on this scale is like an inch on a ruler.

Latent regression. The latent regression model is an extension of the previously mentioned Rasch family model. However, θ is replaced with the model:

$$\theta_{p\,,} = \sum_{j=1}^{J} \theta_{\,j} Z_{pj} + \epsilon_P$$

Z_{pj} is the value of person (p) on person property (j). $\theta_{j,}$ is the fixed regression weight of person property (j) (e.g., age; gender). ϵ_P is the remaining person effect after the effect of the person properties is accounted for (i.e., error). The latent person variable θ_p is being regressed on external person variables (e.g., age, gender, diagnosis). The person regression parameters are fixed effects. Through this regression we are essentially seeing the effect of the person property on theta $\theta_{p\,,}$. In this case, we are regressing the person properties (i.e. age , gender) on theta $\theta_{p\,,}$ to see how those characteristics impact the likelihood of receiving a particular score on an item.

Scoring respondents. For this study, this construct was hypothesized to be unidimensional, reflecting a range from high to low. A respondent's location on this unidimensional construct was determined based on the pattern of the participants' responses across all items, while also factoring in the estimated item difficulty estimates (De Boeck & Wilson, 2004).

Summary. Two groups took this instrument, autistic and typically-developing individuals. Each group was randomly assigned to a sub-group (groups A, B, C, D). Groups A and B consists of randomly assigned autistic individuals. After phase 1, Group A read the narratives in comic format. Group B read the narratives in text-format. Groups C and D consisted of typically-developing individuals. Groups C read the narratives in comic format and group D read it in text format. In order to quantify the impact of the comics, autism diagnosis, text-format of narratives, perceived comic experience, and their interactions, these features were treated as person-side characteristics used for a latent regression analysis.

CHAPTER 3: RESULTS

Since this effort to understand the impact of presentation mode (comic vs. text) on the capacity of students' engagement in integrative reasoning—leading to ever increasing levels of conceptual integration—hinges on the capacity to assess integrative reasoning as a sophisticated and hierarchical construct (i.e., with validated levels of the construct ranging from a little to a lot), I used measurement tools, rather than traditional statistical analysis tools, to conduct the primary analyses. Thus, the central results are displayed on Wright Maps (Wilson, 2005) rather than conventional regression tables. I also provide means and standard deviations for the key outcomes and predictor variables that were involved in the analyses to allow readers to traverse conventional reports of the performance data. See table 4 for the participant's demographics, and table 7 for participant groupings.

Table 7
Participant Groupings: Diagnosis by Format Frequency

		Format	
Diagnosis	Text-Only	Comic	Total
Typically Developing	54	58	112
Autism Spectrum	8	10	18
Total	62	68	130

Phase 1: Screening results

The following *t*-tests were ran to compare mean scores of autistic and neurotypical respondents across both narratives—comic plus text (fishing narrative), and text-only (soccer narrative). One point was allotted to each question, with a total of six literal questions per narrative. Tables 8-11 describe the descriptive statistics for each of the two narratives among autistic and neurotypical respondents.

Table 8
Fishing Story Descriptive Statistics for Autistic Respondents

Autistic respondents reading fishing story (comic plus text)			
Item	Count	Mean	Std. Dev.
Item 1	20	1	0
Item 2	20	1	0
Item 3	20	1	0
Item 4	20	1	0
Item 5	20	.95	.224
Item 6	20	1	0

Table 9
Fishing Story Descriptive Statistics for Neurotypical Respondents

Neurotypical respondents reading fishing story (comic plus text)			
Item	Count	Mean	Std. Dev.
Item 1	125	.976	.154
Item 2	125	.976	.154
Item 3	125	.984	.126
Item 4	125	.96	.197
Item 5	125	.976	.154
Item 6	125	.976	.154

Table 10
Soccer Story Descriptive Statistics for Autistic Respondents

Autistic respondents reading soccer story (text-only)			
Item	Count	Mean	Std. Dev.
Item 1	20	1	0
Item 2	20	.95	.224
Item 3	20	.75	.444
Item 4	20	1	0
Item 5	20	.95	.224
Item 6	20	.7	.450

Table 11
Soccer Story Descriptive Statistics for Neurotypical Respondents

Neurotypical respondents reading soccer story (text-only)			
Item	Count	Mean	Std. Dev.
Item 1	125	.976	.154
Item 2	125	.976	.154
Item 3	125	.952	.215
Item 4	125	.984	.126
Item 5	125	.968	.177
Item 6	125	.960	.197

Using the means and standard deviations in Tables 8-11, a variety of *t*-tests were performed. For autistic students the average scores on the comic and text were 5.95 and 5.35 out of a total score of 6, respectively. This difference of 0.6 points was statistically significant (t=3.27, df=19, $p<0.01$). Although significant, autistic respondents almost received full credit across both narratives. However, there were two items (item 3 and item 6 on the soccer story) that were lower than the other scores. These two items are of interest because even though they have a text-explicit QAR, as the answer is explicitly present in the narrative, the items were posed as a perspective taking question. For example, item 3 asked, "*what did Lacey want Ashley to do in the first game?*," and item 6 asked, "*what does Lacey think about Ashley's ability to play soccer*?" This provides evidence that autistic individuals have challenges with perspective taking

(White et al., 2009), and is demonstrated in this case despite a text-explicit relationship. Nonetheless, the maximum levels were almost reached among other items.

For neurotypical students the average scores on the comic plus text and text-only were 5.848 and 5.816 out of a total score of 6, respectively. This difference of 0.032 points was not statistically significant (t=.367, df=124, p>0.05). Here the neurotypical peers did not have challenges with item 3 and 6 from the soccer story in the text-only format.

For neurotypical and autistic respondents the average scores across the soccer narrative were 5.350 and 5.816 out of a total score of 6, respectively. This difference of -0.466 points was statistically significant (t=-2.666, df=143, p<0.01). This suggests that the neurotypical respondents had an easier time with the text-only format. Again, although significant, both groups scored an average of over 5 points out of 6.

For neurotypical and autistic respondents the average scores across the fishing narrative (comic plus text) were 5.950 and 5.848 out of a total score of 6, respectively. This difference of 0.102 points was not statistically significant (t=-2.666, df=143, p<0.01). Again, both groups scored an average of over 5 points out of 6.

Phase 2: Wright Map Portraying the Results of the Main Study

One of the advantages of using latent variable modeling is being able to locate items and people, along with the corresponding level of the construct map, on a single metric (see figure 15). This logit scale serves as a *ruler* due to the increase of a given magnitude, say .2 logits, indexes an identical increase at any point in the range, which runs from -2 to +2 logits. The Xs to the left of the ruler represent participants. Those high on the ruler represent that they have a high likelihood of responding at higher levels when reading the assessment's narratives. Highly placed students tend to spontaneously integrate when engaging in inferential reasoning in the context of responding to the assessment's items. Those toward the bottom of the scale tend not to integrate spontaneously when responding to questions on the assessment's narratives. To the right of the ruler are columns, each representing a single item, ranging from item 1 to item 12. Within each column are three levels, and in this case thresholds. The purple, 1.1, represents item 1 at threshold 1. The next level above that is 1.2, which represents item 1 at threshold 2, following with 1.3, item 1 at threshold 3. Broadly speaking, as one moves from x.1 to x.2 to x.3, more of the construct is needed to score at that level for a given item. However, a more technical explanation clarifies this Wright Map further.

Take item 1.1 as an example. To the left of 1.1 is an X. This X is aligned with 1.1, meaning that this student has a 50% chance, to score into category 0 vs. 1, 2, or 3 cumulatively, for that specific item. Students (the Xs) aligned with 1.2 represent people who have a 50% chance to score into category 0, 1 vs. 2 or 3, cumulatively, for item 1. Students aligned with 1.3 have a 50% chance of scoring into category 0,1,2 vs. 3, cumulatively, for item 1. Students who are literally lower on the ruler, relative to a particular level for a given item, have less than a 50% chance of scoring into the associated categories. Students who are higher on the ruler, relative to a particular level for a given item, have greater than a 50% chance of scoring into the associated categories.

It is important to note, since these values are thresholds for a partial credit model, 1.1 will always be below 1.2, and will always be below 1.3. However, that is not to say that across all items, threshold 3 will be grouped together above all threshold 2s and all threshold 1s. In fact, they could be mixed together within and across items. The rampant intermixing of levels, when the x.1, x.2, and x.3s are not sequentially aligned, suggests that the theory underlying the

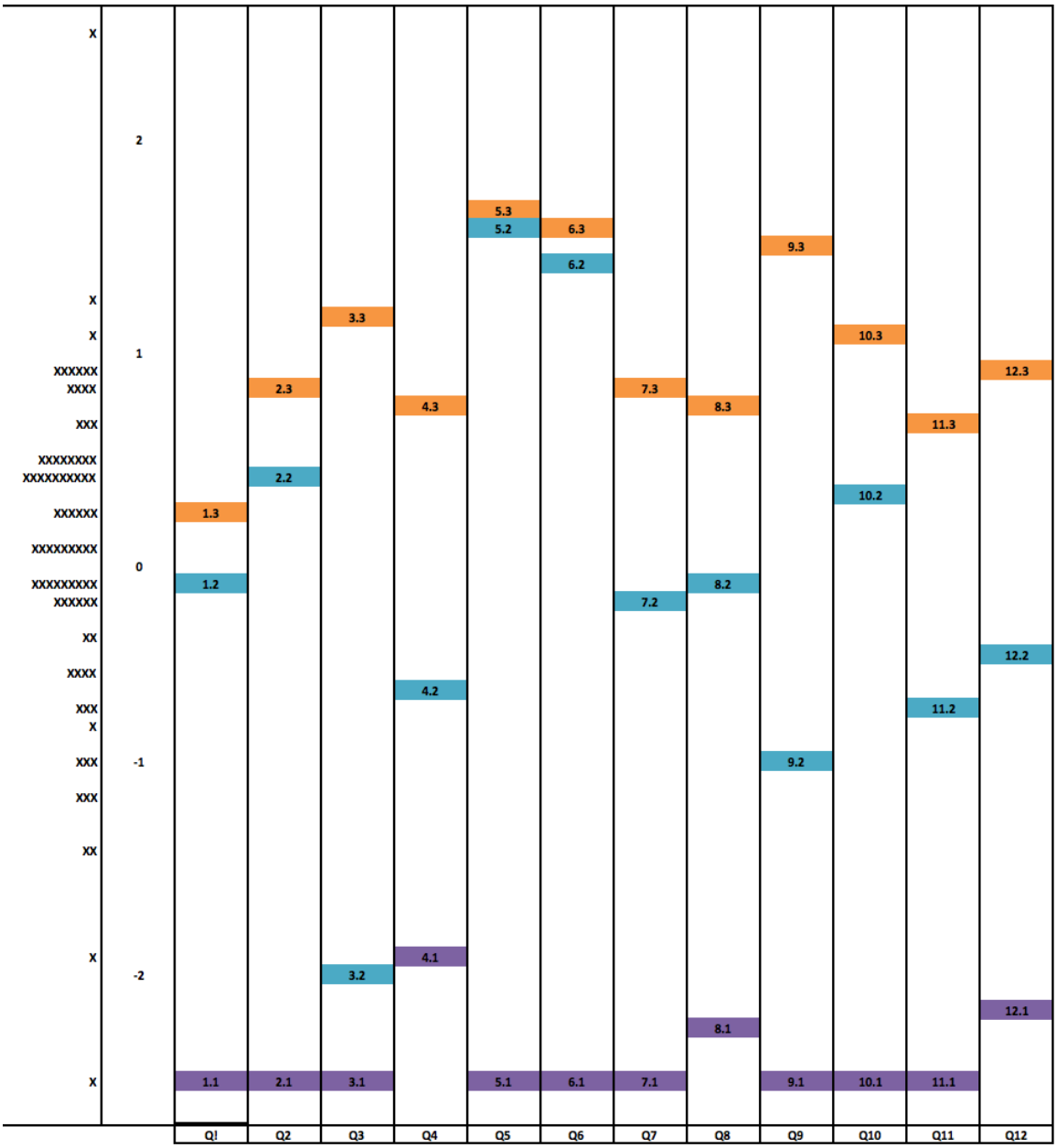

Figure 15. Threshold Wright Map. A demonstration of the levels of IIR.

construct is not valid. In the current analysis for the current set of narratives, most of the .3s (the orange bands) are grouped together above most of the .2s (the blue bands), above most of the .1s (the purple bands). This banding demonstrates an ordinal relationship among the categories within the construct. This current empirical ordering in Figure 15 suggests that the underlying construct, which moves from text-explicit responses to text-connecting to script-connecting to both text- and script-connecting responses, may provide a valid explanation of the findings.

Proficiency Estimates for Items and Respondents

Another advantage of latent variable modeling, more specifically item response theory, is the ability to investigate relationships at the item level. Keep in mind, the partial credit model

generates an overall latent estimate (score) for each respondent, also known as theta, based on what categories he scored into for a set of items—it is a proficiency score. This score represents their overall position on the ruler; thus, they have a certain likelihood to score into each category for each item. The partial credit model uses the estimates for individuals from the model to average thetas across respondents across all levels within each item or the Mean-Location (ML). In this case each item level (0-3) has a ML on the logit scale (see table 12). Should there be a disordering of mean theta, this suggests that perhaps the levels within construct under investigation are not ordinal; however, the opposite holds true should there be an increasing ordering of thetas, supporting the ordinal structure of the construct.

Table 12
Mean Person Locations within Each Level of Each Item.

Item	Category	Count	Mean θ (logits)	Item	Category	Count	Mean θ (logits)
Item 1	0	0	NA	Item 7	0	4	-0.48
	1: Text-Implicit	57	-0.20		1: Text-Implicit	49	-0.26
	2: Script-Implicit	16	0.02		2: Script-Implicit	41	0.17
	3: Combination	55	0.24		3: Combination	34	0.33
Item 2	0	3	-1.38	Item 8	0	8	-0.77
	1: Text-Implicit	75	-0.15		1: Text-Implicit	47	-0.18
	2: Script-Implicit	20	0.32		2: Script-Implicit	36	0.18
	3: Combination	30	0.37		3: Combination	35	0.30
Item 3	0	1	-1.37	Item 9	0	1	-1.37
	1: Text-Implicit	11	-0.58		1: Text-Implicit	32	-0.08
	2: Script-Implicit	85	0.03		2: Script-Implicit	75	-0.03
	3: Combination	31	0.22		3: Combination	22	0.39
Item 4	0	9	-1.12	Item 10	0	3	-1.27
	1: Text-Implicit	30	-0.30		1: Text-Implicit	71	-0.17
	2: Script-Implicit	50	0.21		2: Script-Implicit	31	0.22
	3: Combination	39	0.27		3: Combination	25	0.45
Item 5	0	1	-0.88	Item 11	0	3	-1.10
	1: Text-Implicit	118	0.01		1: Text-Implicit	33	-0.32
	2: Script-Implicit	2	-1.04		2: Script-Implicit	50	0.15
	3: Combination	8	0.59		3: Combination	42	0.23
Item 6	0	5	-0.91	Item 12	0	8	-1.05
	1: Text-Implicit	109	-0.01		1: Text-Implicit	36	-0.19
	2: Script-Implicit	6	0.49		2: Script-Implicit	52	0.16
	3: Combination	9	0.57		3: Combination	32	0.34

For example, consider item 2. 75 respondents, among the whole sample, were located at level 1 (text-implicit). The average ML for those 75 respondents is -0.15 logits. For level 2, the ML is 0.32, and level 3 the ML was 0.37. These MLs could be ordered either consistently with the underlying theory (i.e., 3>2>1>0), opposite of the theory (i.e., 0>1>2>3), or something in-between (e.g., 3>1>0>2). In the current case, except for item 5, all MLs increase from level 0 through level 3. I would like to note that there were only two people in the disordered category (category 2) for this item, so this is not very meaningful. Thus, looking at scores across all

categories of students and items, the observed scaling of levels within items provides strong support for the IIR construct.

Using the Full Range of Variables to Predict IIR Scores

I used latent regression analysis to determine which between person level variables (i.e., age, format, gender, autistic diagnosis and use of speech to text software) and within person variables (i.e., self-rated comic experience) to predict where individuals might be located on the IIR scale.

The initial regression (see table 13) indicated that neither age, nor the use of speech-to-text software explained significant IIR score variation, so both were removed in favor of a subsequent, more parsimonious model, which is represented in tables 13 and 14.

Table 13
Main Effects for Latent Regression

	Latent Regression	
Predictor Variable	Coefficient	STD Error
Age	0.005	(.024)
Comic (Format Type)	-0.171	(.099)
Girl (Gender)	0.291*	(.101)
Autistic (Diagnosis)	-0.534*	(.165)
Self-Rated Comic	0.186*	(.061)
Experience	-0.164	(.122)
Speech-to-Text tool		

Note. *p < .05

Table 14
Model 1: Main Effects

Predictor Variable	Beta Coefficient	STD Error
Comic (Format Type)	-0.182*	(.099)
Girl (Gender)	0.294*	(.101)
Autistic (Diagnosis)	-0.553*	(.161)
Self-Rated Comic	0.175*	(.061)
Experience		

Note. *p < .05

Format and diagnosis were found to be negative predictors of a person's proficiency when controlling for all of the other variables in the model—self-rated comic experience, gender, format, diagnosis. However, self-rated comic experience was found to be a significant predictor, at the 5% level, of scoring into relatively higher categories of IIR when controlling for all other variables in the model. Based on these main effects for diagnosis (autistic), format (comic plus text), and self-rated comic experience (0-3), follow up models involving 2-way interactions were performed; namely–format by autistic diagnosis, format by self-rated comic experience, and autistic diagnosis by perceived comic experience (see table 15).

Table 15
Model 2:Two-Way Interactions

Predictor Variable	Coefficient	Std Err
Constant	0.252	(.162)
Comic (Format)	-0.802*	(.211)
Female (Gender)	0.256*	(.092)
Autistic (Diagnosis)	-0.934*	(.325)
Perceived Comic Experience	-0.106	(.080)
Comic x Perceived Comic Experience	0.400*	(.111)
Autistic x Comic Experience	0.375*	(.128)
Autistic x Comic Format	-0.615*	(.289)

Note. *p < .05

The two-way interactions complicate a straightforward interpretation of the main effects. For example, the interaction between the autistic diagnosis and format suggests that if the respondent was diagnosed on the autism spectrum and received a comic format, they were negatively impacted in terms of their likelihood to score into relatively higher categories of IIR. However, if the respondent was diagnosed on the autism spectrum and had relatively higher perceived comic experience, they were positively impacted in terms of their likelihood to score into relatively higher categories of IIR. Comic format and perceived comic experience was also found to be a significant, positive predictor of scoring into relatively higher categories of IIR.

Since the variables of autistic, comic format, and perceived comic experience were used in the two-way interactions, the main effect of comic format represented the difference between being assigned to a comic group and being assigned to a text-only group for the typical developing sample with no perceived comic experience. In short, members of that group had a decrease of 0.802 logits, which was significant at the 5% level. The main effect of autistic diagnosis now means the difference between being autistic and typically developing when assigned to the text-only group and with no perceived comic experience. In this case, individuals in that group had a decrease of 0.934 logits, significant at the 5% level. Perceived comic experience represented the condition where the respondent is typically developing and assigned to the text-only format. Essentially, for every one unit increase in comic experience, members of the typically developing group assigned to text had a decrease of 0.106 units in logits; however, this was not significant at the 5% level. The question then became, what if the group consisted of autistic respondents who were assigned to comic format, and had high levels of comic experience. In order to answer this question, a three-way interaction was needed (see table 16).

The three-way interaction was significant at the 5% level. Respondents who fell into the group of being autistic and were assigned to comic format, had an increase of 0.671 logits for every one unit increase in comic experience. However, the other variables now take on a different meaning. In order to demonstrate this three-way interaction, it is best to think of it in terms of hypothetical groups, based on the variables used. Table 17 shows the impact of these various combinations of variables on ones position on the IIR assessment.

Table 16
Model 3: Three-Way Interaction

Predictor Variable	Coefficient	Std Err
Constant	0.127	(.164)
Format (Comic)	-0.520*	(.230)
Gender (Female)	0.262*	(.090)
Diagnosis (Autistic)	-0.268	(.413)
Self-Rated Comic Experience	-0.035	(.082)
Format (Comic) x Self-Rated Comic Experience	0.234	(.124)
Diagnosis (Autistic) x Self-Rated Comic Experience	0.036	(.185)
Diagnosis (Autistic) x Comic Format	-1.884*	(.535)
Diagnosis (Autistic) x Comic Format x Self-Rated Comic Experience	0.671*	(.249)

Note. *p < .05

In table 17, the first set of columns represent hypothetical groups. They are marked 0 for when the variable is not present, 1 for when the variable is present. Based on which variables are present or not present, the coefficients for the variables will or will not predict the proficiency for the group of respondents. For example, the first row represents being a boy, who is autistic, who was assigned to the text group, and has no self-rated comic experience. The ML for this group is - 0.141. There are 16 possible combinations using the variables gender (0= boy, 1= girl), diagnosis (0= typically developing, = autistic), format assignment (0= text only, 1= comic), and self-rated comic experience (0= none, 1= a little, 2= some, 3= a lot). Based on these hypothetical groupings, all 16 combinations were given an ML score and positioned on the Wright Map (see figure 16). The Wright Map (see figure 16) includes the ML of each group combination to the left of the ruler and the associated levels (thresholds) on the right of the ruler. A note, due to the small sample size, the number of subjects in these groups were often relatively small and should interpreted with caution.

Table 17
Group Mean Location Table

Mean Location of Group Means from Three-way Interaction (Model #3)				
Girl	Autistic	Comic Format	Self-Rated Comic Experience	Mean Location on IIR Scale
0	1	0	0	-0.141
0	1	0	2	-0.139
0	1	0	3	-0.138
0	1	0	1	-0.14
0	1	1	0	-2.545
0	1	1	1	-1.639
0	1	1	2	-0.733
0	1	1	3	0.173
0	0	0	0	0.127
0	0	0	1	0.092
0	0	0	2	0.057
0	0	0	3	0.022
0	0	1	0	-0.393
0	0	1	1	-0.194
0	0	1	2	0.005
0	0	1	3	0.204
1	1	0	0	0.121
1	1	0	1	0.122
1	1	0	2	0.123
1	1	0	3	0.124
1	1	1	0	-2.283
1	1	1	1	-1.377
1	1	1	2	-0.471
1	1	1	3	0.435
1	0	0	0	0.389
1	0	0	1	0.354
1	0	0	2	0.319
1	0	0	3	0.284
1	0	1	0	-0.131
1	0	1	1	0.068
1	0	1	2	0.267
1	0	1	3	0.466

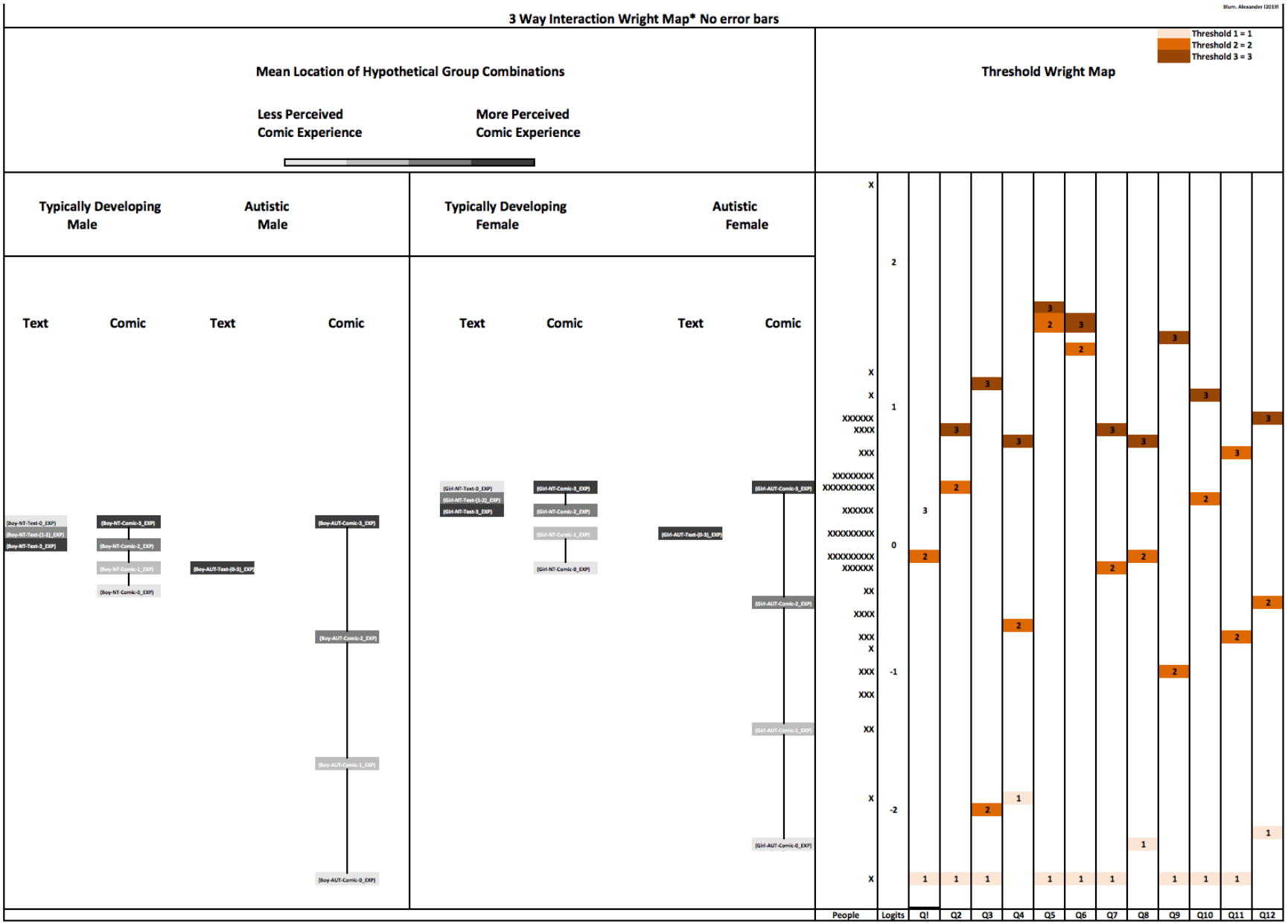

Figure 16. Three-Way Interaction Wright Map

Reliability Measures

Item-level fit. In addition to examining the positionality of various groups on Wright Maps, it is also important to see how items are behaving as a whole, and how well they are tapping into each individual level within each item. Based on item difficulty estimates and person proficiency estimates, there is an observed scoring pattern and a predicted pattern. The degree to which these items overlap is called the Weighted Mean Squared (WMNSQ). If an item's WMNSQ is less than 0.75, it suggests that the manner in which people responded to the given item was too predictable, having less of a degree of randomness than the model predicted, but is not seen as a major problem. A problem present itself when the item's WMNSQ is greater than 1.33, which suggests that there is too much randomness relative to what the model predicted. Essentially, people with high proficiency scores are getting easier items wrong, and people with relatively lower proficiency scores are getting harder items correct, inconsistently, for a particular item. Thus, an item's WMNSQ, for both formats, should ideally fall within the range of .75 and 1.33. Table 18 below represents this instruments item fit.

Table 18
Item Fit Statistics

Item	WMNSQ	Item	WMNSQ
1	1.15	7	1.04
2	0.93	8	0.96
3	1.01	9	1.05
4	0.93	10	0.95
5	1.08	11	0.99
6	1.00	12	.98

Note. Based this table the WMNSQ for each item falls within the acceptable range between 0.75 and 1.33. Table 19, below, takes a closer look and identifies the fit measures for each response category for each item.

Person separation reliability. Person separation reliability was also calculated, using the Weighed Likelihood Estimation. This measure ranges from 0 to 1 and represents how well the instrument was able to separate people with varying ability levels. For the IIR assessment the WLE coefficient was 0.743. Although this reliability coefficient falls within the adequate range, the assessment, and its reliability would likely improve with the inclusion of more items. The more items in the analysis, the more data points available to separate respondents with similar but not identical proficiencies, leading to more accurate estimates.

Internal consistency. Internal consistency was indexed with coefficient alpha. Alpha is based upon all of the possible split-half combinations one can make from a given test; it estimates how correlated all of the resulting halves are; more specifically, how much shared variance they have compared to unique variance. Essentially, if the items have a lot of shared variance relative to unique variance, among items, the stronger the internal consistency. A coefficient alpha of 0.64 was found, which is marginal even for an experimenter designed assessment. Again, more items would likely result in a boost in the overall alpha coefficient.

Table 19
Item Fit Statistics by Item by Level

Item	Level	WMNSQ	Item	Level	WMNSQ
1	0	NA	7	0	1.01
	1	1.14		1	1.02
	2	1.00		2	1.01
	3	1.12		3	1.04
2	0	0.92	8	0	0.89
	1	0.98		1	1.00
	2	0.99		2	1.00
	3	0.99		3	1.02
3	0	1.08	9	0	1.01
	1	0.97		1	1.11
	2	1.03		2	1.04
	3	1.07		3	0.99
4	0	0.83	10	0	0.97
	1	0.99		1	0.98
	2	0.99		2	0.99
	3	1.07		3	1.00
5	0	1.02	11	0	0.96
	1	1.09		1	0.99
	2	1.03		2	0.99
	3	1.06		3	1.05
6	0	0.96	12	0	0.86
	1	1.01		1	1.04
	2	1.00		2	0.98
	3	1.03		3	1.04

Note. All WMNSQ are within the acceptable range.

Validity

Evidence based on the instrument content. Wilson's (2005) Berkeley Evaluation and Research Assessment framework was used in the construction of this instrument, which cycles the researcher through an iterative process. The first step is creating a construct map of the hypothetical construct based on research. The second is item design, where one creates items that are designed to tap into different levels of the construct map, to gain maximum information. Third is the outcome space, where a scoring guide is made to classify responses into their appropriate categories in the construct map. Fourth is choosing the right measurement model. Since this construct was hypothesized as ordinal, and with a series of levels, the Partial Credit model was used, which is a Rasch family model.

The measure was further refined and calibrated. This instrument was also designed to measure one's integrative inferential reasoning (IIR), not in terms of achievement, but rather in terms of their disposition or inferential preference. It ranges from the explicit absence of inferential reasoning to highly integrative inferential reasoning (Chikalanga, 1992; Graesser et al., 1994; Pearson & Johnson 1978; Warren et al., 1979).

Items were designed based on inferential thinking categories of Warren et al., (1979) – motivational inferences and evaluative inferences. The answer is not explicitly stated in the

comic and thus answering the items required inferential reasoning. The participants could use any aspect of the narrative and their background knowledge to generate an inference. A new item was posed to further tap into the landscape of the respondents reasoning called the meta-reasoning item (i.e., what made you think of that answer).

An outcome space was then determined based on the literature (Chikalanga, 1992; Graesser et al., 1994; Pearson & Johnson 1978; Warren et al., 1979). The inferential categories were ranked on an ordinal scale because of the increasingly integrative nature of the inferential reasoning required as one moves across levels. The scale did not meet the assumptions for a cardinal scale because it was not possible to define "zero" integration.

Evidence based on response processes. Exit interviews were conducted at the end of the comic survey. Respondents were asked if there were any questions they didn't understand, and if so, which ones. There was some unfamiliarity about the meta-reasoning item for a few respondents, but otherwise respondents reported understanding the questions. Cognitive labs (e.g., think-aloud) were also conducted to better the respondents' thought process while they engaged with the narratives and answering the survey questions.

Evidence based on internal structure. This instrument was also evaluated based on the trajectory of the responders mean location increase across each level, (see table 17 for demonstration of this ML increase). In addition, there was banding of the thresholds across items, suggesting that people use fairy consistent types of reasoning on average across items, supporting IIR as a cognitive processing disposition, (see figure 15).

Evidence based on relations to other variables. For the diagnosis category, using a latent regression, it was found that those diagnosed, in the sample, as autistic had a decrease in their proficiency score by -0.553 logits, suggesting that a autism diagnosis is a negative predictor of scoring relatively higher on the IIR construct based on the given items. This was hypothesized due to evidence that individuals with autism have been known to have unique cognitive processing dispositions; more specifically, they have been known to have a detailed-oriented (local coherent) cognitive processing biases (Frith, 2003; Frith & Happe, 1994; Happe & Booth, 2008; Happe & Frith, 2006). This can impact capacities to draw on inferences and integrate world knowledge, along with contextual details, needed to gain a coherent understanding of narratives, leading to challenges in comprehension (Baron-Cohen et al., 2003; Capps, et al., 2000; Happe, and Frith, 2009; McIntyre et al., 2018; McIntyre et al., 2017; Nuske & Bavin, 2011; Rump, Kamp-Becker, Becker & Kauschke, 2012; White, Hill, Martin & McDonald, 2004).

Evidence based on consequences of using IIR. Since this instrument is not yet in wide-scale use, no data were currently available on consequences of its use. As instrument authors, we wish to stress that this instrument does not attempt to measure one's ability in terms of achievement. Rather, was is designed to measure one's cognitive processing disposition, in the context of spontaneous reasoning. Therefore, it would be inappropriate to interpret IIR results in an achievement context, such as course selection, assignment of grades, or readiness for more advanced courses.

CHAPTER 4: TAKING STOCK

Summary and Discussion

The purpose of this chapter is to take stock of the contributions of this project by: (a) providing a brief overview of the findings, (b) discussing their theoretical and practical significance as well as the limitations of the work, and (c) detailing the conclusions and implications that the work has for future research, educational practice, and theories that attempt to explain the reasoning, particularly the inferential reasoning, of mainstream and autistic students in our schools.

Summary

This project is rooted in both theoretical and practical goals. The theoretical quest is building a more integrated account of inferential reasoning that, among other things, can explain the inferential skills and pathways of autistic students. The practical tradition stems from our long-standing pursuit to understand and improve the reasoning skills of students who lie on the autism spectrum.

As educators, we need to address the perceived challenges in narrative comprehension for autistic students (Capps et al., 2000; White et al., 2009;). Areas of weakness have been described in terms of lack of causal language use (Rump, et al., 2012), limited use of internal state language (Capps et al., 2000), deficits in script implicit inferences (Nuske & Bavin, 2011), deficits in perspective taking (White et al., 2009), and challenges in context integration (Frith, 2003; Frith & Happe, 1994; Happe & Booth, 2008; Happe & Frith, 2006). But notions of deficits have also been considered in the context of differences, such as positioning autistic individuals as possessing a disposition towards details (local coherence; Happe & Booth, 2008; Happe & Frith, 2006), and images (Gaffrey, et al., 2007; Kamio & Toichi, 2000). This sheds light on the notion that autistic individuals may engage in lower levels of IIR.

The driving goal for this project was to search for a way to naturally promote IIR in a non-invasive manner for all students, but especially for autistic students. Building on the spirit of universal design for learning (change the context, not the person), I reasoned that visual input would complement the verbal modality of print. I also hypothesized that comic representation would capitalize on autistic individuals' theorized disposition towards images, and thus naturally promote IIR among autistic students. Comics would make the latent and obscure information more transparent and explicit, serving as a launchpad to integrate the information encountered in text with their world knowledge spontaneously and without arduous effort.

This hypothesis licensed quite specific predictions about the findings; namely that all readers would benefit from the addition of comic representation to otherwise conventional print texts and that the comic format would be particularly helpful for autistic students. In short, there would be a main effect for format favoring comic plus text over text-only for the autistic population. However, the main effect was complicated by a disordinal interaction between comic plus text format and an autism diagnosis, such that the comic plus text over text-only advantage would be significantly greater for autistic than neurotypical students. The findings did not support these theoretically well-motivated predictions. Instead they told a much more complicated story.

On the surface, it would appear that autistic respondents demonstrated deficits in IIR, serving, as evidence to support the weak central coherence theory, which posits that challenges to integration are not context specific. The current findings appear to suggest that comics do not, in fact, promote greater IIR than text; to the contrary, they suggest that when comics are added to

text, autistic students are penalized even further, leading to even less use of higher levels of IIR (See group location in figure 16).The group of autistic students who engaged with the comic format, with no self-reported comic experience, were more than 2 logits lower on the IIR scale than their neurotypical peers in the sample. In fact, the autistic group who engaged with text-only narratives scored significantly higher than the autistic group with little to no self-rated comic experience and engaged with the comic plus text format. This is counter to the working hypothesis of this study and does not support the notion of augmenting text with images as a way of promoting the integrative reasoning of students, most especially autistic students.

However, using different measurement approaches illuminates the nuances of these relationships further, painting a different picture, or seeing a different vantage point of the narrative. Although a local processing disposition does in fact impact engagement in IIR, and comic plus text format does not seem to help, self-rated comic experience serves as a powerful factor that seems to moderate the efficacy of images and drives IIR scores up. This impact was specific to comic plus text format regardless of diagnosis, but its influence was especially pronounced among the autistic respondents.

In the following discussion, I will explore the intersection of autism, narrative, and inferential reasoning in the context of meaning making. This was made possible through the principles and practices of the item-response theory and the BEAR assessment framework (Wilson, 2005). Through the BEAR application, I was able to integrate different types of inferential reasoning frameworks to illuminate different facets of the cognition behind QARs and its relationship with comics and autism. By modeling IIR, a type of cognitive processing disposition, I was able to highlight nuances in the manner in which a local processing disposition impacts inferential reasoning, the relationship between comics and inferencing, and the unique challenges autistic respondents possibly face when engaging with narratives. In doing so, I have found evidence to support some of the theoretical underpinnings of autism, specifically central coherence theory (CCT), while at the same time challenging the unitary characterization of CCT of the autistic community.

Discussion

A useful way to discuss the findings is to address a set of highly relevant questions that possess two features: (a) they are prompted by the effort, either directly or indirectly, and (b) there is evidence in the findings to actually address them. Several of the questions relate more to the theoretical aspects of the project and speak to what we learned about IIR's capacity to explain the results obtained. Other questions center more on the experience of the relatively small sample of autistic students, particularly on how they responded to different formats of presentation (text-only vs. comic plus text),

Impact of local processing disposition on students' inferential reasoning. Central Coherence Theory (CCT) (Frith, 2003; Frith & Happe, 1994; Happe & Booth, 2008; Happe & Frith, 2006) positions autistic individuals as having a disposition toward local over globalprocessing. This disposition translates into particular types of student thinking; namely attention to details, chaining propositions, and the creation of enumerative rather than integrative summaries of text. Text-implicit QARs (Pearson & Jonson, 1978) favor this line of thinking since they do not require the integration of world knowledge, but rather operate within the propositional facts of the narrative. In addition, relying on details in the narrative to serve as the evidentiary basis for making an inference may seem to be safer, in terms of predictability and risk-avoidance.

This local processing disposition may represent a safe harbor, but it can limit flexibility in thinking. If a learner is more flexible in their inferential thinking, they would likely know that they are not bound by the information in the narrative, realizing that their response can be informed by world knowledge and go beyond the text-base. Autistic individuals have been described as limited in flexibility (American Psychiatric Association, 2013), preferring more predictable literal stances. The data for autistic students supports this account of their dispositions. When controlling for a wide range of other variables (e.g., gender, format, and self-rated comic experience), a diagnosis of autism positions students at the lower levels of the IIR scale, meaning that they are more likely to offer more text-based responses to comprehension questions.

Do comics promote IIR? In order to see if comics promoted IIR, multiple regressions were conducted. First, using a latent regression in model 1, the predictor variables comic format, autistic diagnosis, female gender, and self-rated comic experience were regressed on respondents' proficiency scores. Comic format was found to be a negative predictor of engaging in higher levels of IIR. This suggests that when controlling for all listed variables, comics tended to elicit relatively more text base, literal QARs. This was surprising, based on the assumptions I had about the universal appeal and affordances of comics, and how they can promote integration of ideas in a narrative with prior knowledge. Even more surprising, given my assumptions, the two-way interaction (model 2) between autism diagnosis and comic plus text format showed that comic plus text suppressed integration even more among autistic than mainstream learners.

Flexible thinking: challenges for autistic respondents who struggle with comics. The failure of comics to promote IIR was puzzling in light of a body of research that position comics as a great literacy tool, particularly for autistic students (Gray, 1994; Rozema, 2015), who often exhibit a visual processing disposition (Gaffrey, et al., 2007; Kamio & Toichi, 2000). Could it be that when the respondent is seeing the images (especially if they mirror the words in the text), there is less reason to go beyond the narrative to invoke world knowledge to answer the inference probe? The information in front of participants could easily be used to craft an answer. If so, it would explain why the direction of the main effect (model 1) for the autistic diagnosis was significant and negative, suggesting a preference for staying close to the text. However, this conjecture fails to take into account learners' self-rated comic experience. Perhaps, without comic experience, there is less reason to be flexible and realize that their own memories and world knowledge is just as relevant to the inference as is the information in the narrative text-base. This could be plausible, due to the fact that when self-rated comic experience was introduced to the model the direction of the coefficient flipped. Meaning those learners who rated themselves high on comic experience benefitted from the addition of comics in the comics plus text condition. The effect was especially pronounced for autistic students. That is, in the three-way interaction (model 3) self-rated comic experience by autistic diagnosis by comic format was significant. Comic format by self-reported comic experience (Model 2) was also found to be significant, suggesting that increasing self-reported comic experience promoted IIRwhen respondents were assigned to the comic group, regardless of diagnosis. Then, perhaps self-rated comic experience serves as a sort of schema to build from, and the learner knows they do not need to only settle for the details in the narrative, but rather choses to use them to engage in higher levels of IIR

Why would respondents struggle with comics: grammar and literacy. Another plausible explanation lies in the format of comics. Taking a closer look at comics, they are more than pictures. As discussed in the literature review, comics, or rather narratives in a multi-modal

sequential image format, have their own grammar and can serve as a visual language (Cohn, 2010; 2013; Cohn, et al., 2012). These grammatical markers enhance the semiotics behind the panels and guide the learner through the landscape of comics. It is a form of literacy in itself (Nakazawa, 2005). A learner who possesses relatively little comic experience may find them confusing medium to interpret. There is so much inferential thinking involved between agents and narrators within each panel, even more across panels. Plus, if learners do not know what these grammatical markers suggest they may regard the display as a series of disjointed ideas. In short, comics may not be universal (Cohn, 2016). For example, Cohn (2016) found that when comics were presented to subjects in cultures where they were not available, participants did not see them as a sequenced series of events. Instead, they tended to regard them as disjointed entities, where each panel represented a different person.

This impact was not specific to autism, but rather to all respondents assigned to comic plus text format condition. Looking at figure 16, the three-way regression (model 3), and the Wright Map (see figure 15), the more self-rated comic experience students had, the higher their position on the IIR scale. However, the degree of impact seems very different between autistic and neurotypical respondents. Neurotypical respondents with low self-rated experience were positioned at .0.127 logits while neurotypical respondents with higher self-rated experience, were positioned at 0.204, a difference of .189 logits, which is not likely a statistically reliable difference. However, for the autistic group, positionality ranged from -2.545 logits for autistic boys with no self-rated comic experience to .173 logits for autistic boys with three points of self-rated comic experience—a total difference of 2.718 logits. This is the equivalent of having approximately a 45% increase in engaging in higher levels of IIR for items at 0 logits on the IIR scale (Wilson, 2005). Therefore, comic experience moderates the positive impact of the comic plus text format, and the effect of that moderation is especially salient for autistic males.

Why would autistic respondents struggle with comics: difference or deficit in visual integration. Several studies have summarized in a meta-analysis by Van der Hallen and colleagues (2015) suggest that autistic learners demonstrate challenges with visual integration particularly when there are local distractors embedded within a visual task and the outcome variable is response time. However, when the outcome variable is accuracy, those differences did not present themselves. In addition, Enticott and his colleagues (2014) found that autistic participants in their sample exhibited greater challenges with dynamic than static images. With these findings in mind, it would seemingly appear that comic plus text might not be conducive for success in narrative comprehension. Although one can make the argument that the panels and images within them are static, in the sense that there is not physical motion carrying the images forward (e.g., a movie), there are different forms of dynamics taking place cognitively speaking. With this lens, one could argue that there is dynamic action between panels; even within panels there is implied movement in actions, thoughts, and movements, making them at least partially dynamic. Taking this further, one has to make inferences across panels as well. This could explain why the autistic participants with no self-rated comic experience had more challenges engaging in higher levels of IIR when reading comics than those with higher self-rated comic experience. In fact, autistic boys with no self-rated experience who were assigned to comic format were positioned much lower on the IIR scale (ML of -2.545) compared to neurotypical boys with no self-rated comic experience and assigned to comic format (ML of -0.393); for a total difference of 2.152 logits. Due to challenges in visual integration, and lacking comic experience, the comic plus text format may have been confusing, making it easier to settle for lower levels of IIR, leading to their location being low on the IIR scale.

The question becomes, then, how to regard this difference. On the one hand it is a deficit since their mean location on the IIR scale is significantly lower. But is the deficit constitutional (i.e., built into the autistic students) or experiential (i.e., suggesting a lack of opportunity to immerse themselves in the medium)? If an individual not familiar with baseball played for the first time and did not perform well, we would not conclude that they have a baseball deficit. Clearly, if that person continued to play baseball, he would improve. Can the same lens be applied to cognition and particularly forms of integration? This line of reasoning is evoked by the evidence that as the as self-rated comic experience increases among autistic learners, they make show higher scores on the IIR scale. More specifically, 1 unit increase in self-rated comic experience, led to an increase of .671 logits for autistic respondents (model 3). When full self-rated comic experience is taken into account, the autistic boys mean location on the IIR scale is higher than an autistic group of boys assigned to text-only format. Is that self-rated experience associated with changes and development in visual integration? The evidence from model 3 would point in that direction.

What is especially interesting is that the mean location of autistic respondents assigned to comic, with three points of self-rated comic experience, have a very similar mean location as the neurotypical group in both the text and comic group. It appears that the self-rated comic experience brought their use of IIR to a comparable level with their neurotypical peers in the sample. This challenges assumptions of perceived deficits in integration, or deficits on global processing, and rather, demonstrates differences in use of IIR, and that their cognitive processing disposition is situated. In this case, when situated by a comic format, and relatively high self-rated comic experience, autistic respondents have a higher likelihood of engaging in higher levels of IIR, comparable to neurotypical peers.

Other scholars have also posited that autistic learners do not have a deficit in global processing across all contexts, as CCT would suggest. Van der Hallen et al., (2015) found through their meta-analysis that when changing the context for visual integration, such as the outcome measure (e.g., response time vs. accuracy) the global differences don't necessarily present themselves. Meaning there was a global processing delay rather than deficit, since there were no differences found in accuracy, but only in response time. Auditory integration has also been investigated as a context, or modality, to investigate the unitary assumptions of CCT. Mottron et al., (2000) also positioned local and global as ordinal, and used the ordering of (local) pitch, intervals, and contour (global; e.g., rhythm) as their framework for positioning local and global. They found that combinations in pitch lead to intervals, and when intervals continue to grow and develop it turns into rhythm. Mottron et al. had autistic and typically-developing kids listen to two different pieces of music, one at a time, and then were asked if they had the same or different rhythm. The pieces of music were manipulated at different levels (local vs. global), with rhythm being the highest global representation. They found that all participants used the rhythm as a discrimination cue, which is attenuation at the global level. Even when their where changes at the local level, such as pitch, it did not interfere with them processing the rhythm. Mutton et al. essentially showed that differences in pitch did not interfere with the perception of contour similarity. This is different from findings of Van der Hallen et al., 2015 where local level distraction did interfere with global processing in the context of visual integration. Thus, Mottron and colleagues (2000) seem to position local and global as situated in modality, that in the auditory modality using music, global processing was intact.

Positioning autistic individuals as having a unitary deficit in IIR seems an overgeneralization; perhaps their needs as learners need to be situated accordingly to promote it.

This was demonstrated in the 3-way interaction (Model #3) wright map (see figure 16). When autistic respondents had full self-rated comic experience, and were assigned to comic plus text format, their position on the IIR scale is comparable to their neurotypical peers, in both text and comic formats. More specifically, their mean location is aligned with the level two threshold, which is represents relatively more integration, positioned along the lines of global coherence, based on the construct map (see figure 15). Ways of situating could be through priming or scaffolding as a whole. Some elements may simply be more or less inviting of IIR, or local vs. global processing. In this case, IIR was more inviting with comics when they had more self-rated comic experience.

Limitations

The nature of the sample is not random, but rather convenient; as I ran the study with any participant who volunteered and met my inclusion criteria. Ages were limited to 11-18, or from middle to high school. The sample was also geographically limited; all schools were recruited from the San Francisco Bay Area. This study had a relatively small sample size (n=130), and within that, only 18 autistic respondents. Both the overall sample size and the small autistic population limit the generalizability of the findings, which should be regarded with caution, as my hypotheses need further empirical evaluation. There was also an issue of who is absent from the sample altogether; namely English language learners and low-income students. Thus, the overall limited demographic information about the sample is a threat to generalizability. Ideally, learners would be sampled across many demographically relevant factors, and then randomly assigned to treatment conditions.

This study also used short vignettes, rather than fully developed narratives, such as published graphic novels. IIR may look different with larger, longer, more authentic texts. Also, the self-rated scale of perceived comic experience, although it attempts to serve as a proxy for actual experience, does not fully detail the comic reading experiences participants have actually accumulated. The scale needs to be expanded and validated as a psychometric phenomenon.

Future Studies

Intervention possibilities. If self-rated comic experience is a valuable factor in illuminating the differences in engaging with narratives, then interventions need to focus on promoting it. This does not mean just using comics in a reading intervention, rather, it means teaching comics as a genre, comparable to poetry or argumentation. Teaching might entail the lay of the land, the grammatical tools, and strategies to navigate through them. We teach the lay of the land for traditional books to students, as part of emergent literacy practices, and comics could be taught in a similar way. This issue is similar to putting a lot of technology in a classroom and expecting kids to naturally become smarter. The problem is, if the students don't have the digital literacy in navigating through the technology, whether it is software, an iPad, or any other device, then how are they to benefit from them? Comics are a genre with its own literacy, and thus guided experience with this genre is well worth careful exploration and experimentation (Brenna, 2013; Nakazawa, 2005; Panteleo, 2013).

Self-rated experience. But what is so powerful about self-rated comic experience? This is different from objective experience. We don't actually know how much experience the respondents truly had, but their perception serves as a proxy for it. What comes with this perception? Identity development? Perhaps having this increased self-rated experience leads to more confidence and are more able in navigating comics with more experience. Perhaps they have more capital and cognitive resources, such as a schema, to build off of and utilize. Future research should unpack self-rated experience by looking into its affordances. To further validate

self-rated comic experience, it should be examined alongside actual experience in studies where both are measured, and the degree of their covariance evaluated in concurrent validity studies.

Integrated inferential reasoning and narratives. It would also be useful to see how IIR is situated relative to the narrative architecture. Cohn (2013) describes the grammar of visual narratives, which includes a hierarchy of categories of panels as they relate to each other (e.g., establisher, initial, peak, release). More specifically, is IIR situated by the marco-propositions of the narrative? Are people just as likely to engage in higher levels of IIR during the climax, rather than the resolution, vs the establisher? This will tell us what facets of the narrative provide more affordances and opportunities for relatively higher levels of IIR, which tells us where to focus on promoting IIR for a more coherent representation of the narrative.

In addition, these were short stories and not a complete graphic novel, that resembles traditional reading. Perhaps IIR is situated differently in more traditionally lengthier stories. Future studies can investigate IIR in more traditionally lengthen stories, designed for entertainment, giving a more authentic context for IIR to take place.

Outside of comics, IIR on its own should be further investigated. Essentially the construct map of IIR is a taxonomy of inferences. A preschool teacher, for example, could position her students' responses to questions during a shared reading experience, or a read aloud, and scaffold the students higher on the IIR scale. The taxonomy can be used as a progress monitoring tool, a road map of inferences for the teacher to use. Future research can investigate its use in a classroom context, perhaps even as an outcome measure for different interventions that target inferential thinking.

It would also be interesting to look at IIR globally as it is demonstrated in essay responses, such as an analytical essay. By coding the different levels of IIR within an open response analytical essay, one might see how those levels or categories are distributed throughout the essay, at different points in the development of an argument or an explanation. This might give an educator a bird's eye view of how the students are engaging in IIR in a less constrained response format.

Conclusions and Implication

What legitimate conclusions can be drawn from this work? Which of the claims that might be made about the nature of integrative reasoning for adolescents in general and autistic students in particular are supported? What claims about theoretically grounded explanations of integrative reasoning are warranted?

Integrated Inferential Reasoning.

The impact of context on IIR. IIR is not determined by either age or autistic diagnosis among middle and high school student respondents. To the contrary, different levels of IIR are present among both neurotypical and neurodiversity samples (e.g., autistic) across the entire age range. Regardless of diagnosis and age, students engage in different levels of IIR, and do so across both text-only and comic plus text formats. IIR appears to be situated. Although it is a line of thinking, a type of cognition, it is not without context. Although IIR is trait like, it can in fact be developed like any other skill set. This was demonstrated by the influence of including self-rated comic experience in model 1, 2, and 3. With this lens in mind, autistic respondents do not have a unitary deficit in IIR, or global processing for that matter. But there are differences in their cognition relative to the neurotypical sample. Without the impact of self-reported comic experience, autistic respondents were positioned significantly lower on the IIR scale (model 3). This has implications for how we situate autism as a whole. Rather than seeing their challenges in light of deficits, and thinking that challenges in one context amount to challenges in all

contexts, one can see an autistic individual as having a different mode of experience when engaging in the meaning making process; that their unique processing dispositions need to be situated accordingly in order to bring out their full potential.

IIR is the theoretical foundation of the current work. The entire effort could be construed as an attempt to validate IIR as a valid theoretical construct for explaining how individuals, in this case adolescents, comprehend and integrate information encountered in narrative accounts of the world. The IIR construct is specific to narrative comprehension, rather than reading comprehension. One could apply IIR to an oral narrative, multi-modal visual narrative, algebraic narrative, and of course a verbal narrative to say the least. But in its current form, it has not been designed to apply to expository prose of the sort found in essays, scientific descriptions or explanations, or textbooks. It was born during my attempt to integrate a range of prominent literacy theories, all of which attempted to explain the process of constructing meaning and, in particular, drawing inferences (Chikalanga, 1992; Kintsch, 1988; Pearson & Johnson, 1978; Warren, et al., 1979). By its very nature, IIR is spontaneous (in the sense that it is a kind of reasoning that can occur quite independent of any particular environmental prompts—such as questions from a teacher, parent, or peer), and can be seen as a type of cognitive processing disposition. This aspect of IIR is in line with other scholarship that explores cognitive processing dispositions (Baron-Cohen, Richler, Bisarya, Gurunathan, & Wheelwright 2003; Frith, 2003; Frith & Happe, 1994; Happe & Frith, 2006).

IIR and the processing dispositions of autistic learners. IIR provides a useful framework for understanding the relationship and distinction between local and global processing. Much is made in the literature on autism between these two modes of processing. It is commonplace for autism scholars to point to research showing that autistic students are more comfortable with and inclined to focus on local than global processing—seeing the trees but seldom the forest. However, inclination is different than strengths, although they can inform one another. When local and global processing skills are tested in isolation, one cannot say there is a disposition towards local per say, since there was not a global option to choose from, although there may be demonstrated strengths, or at least a lack of weakness. Mottron et al., (2000) posits that when both local and global are available, and local is still chosen as an option, or is engaged with in some targeted manner, that one can argue a disposition towards local. In the current work of IIR, there were no constrained multiple-choice items that might limit the type of reasoning a student could possibly display. All items were open response; respondents chose what they wanted to say, engaging in local and or global processing spontaneously.

Local and global processing have been positioned in different ways. At times their relationship has been investigated by finding statistical differences between performance on different isolated tasks, a multi-dimensional view, such as main idea vs detail questions (Nuske & Bavin, 2011), propositional inferences vs script-implicit inferences (Nuske & Bavin, 2011), embedded figures test where test takers locate shapes within larger shapes (Van der Hallen et al, 2015). In the case of IIR, local and global are not seen as separate or even multidimensional processes, but rather as ordered levels within a unidimensional construct. This relationship is held together by Kintsch's (1988; 1998) construction integration framework, where local and global processes work together to form degrees of integration; both the detail and larger schemata are needed to create what Kintsch has called a situation model—an account of the text at hand that connects the detail and big ideas in a text with one another, and, equally as important, with key ideas from an individual's store of knowledge. By using this framework, a third category can be posited where local and global are integrated. First the local (e.g.,

propositions that lay out the elements of a narrative) instantiates the global (e.g., memories and the schemata that constitute world knowledge). But it must be said that although we have these categories of IIR, they are artificial in nature, and are primarily used to make sense of the construct, item design, and outcome space as they relate to each other. The partial credit model positions IIR as unidimensional and continuous. However, through the psychometric outputs, the levels can be modeled and distinguished relative to item and person locations on the IIR scale.

This is not to say that local and global processing are unidimensional in and of themselves, and they are not necessarily compensatory in all contexts. However, in the context of IIR, these skill sets are used to engage in particular types of inferential reasoning (e.g., text-implicit and script-implicit QARs) that are ordinal in nature. IIR can then be seen as a construct that is: (a) larger than, and probably entails, both local and global processing on their own, (b) represents an integration of these processes (e.g., local and global processing, local and global coherence, and inferential reasoning) that work together to engage in IIR, and (c) represents a type of cognition that is dispositional, and thus spontaneous, in nature.

IIR was made possible through the groundbreaking work of pioneering scholars during the cognitive revolution. It is a testament to the strength of their theoretical frameworks and relevance decades later. Overall, IIR: (a) merges inferential relations—QARs & evaluative and informational relations, (b) is informed by coherence, and (c) held together by the construction-integration framework. However, IIR is not strictly limited to inferential reasoning; rather it describes a form of reasoning in which inferential thinking plays a role. This was demonstrated by applying IIR to the meta-reasoning item (e.g., what made you think of that answer), which is not an inference item, but rather is part of the inferential reasoning process.

The levels of IIR are also distinguishable across most items, and some items are more or less inviting of IIR. When the narrative's text-base was so concrete, such as story 2 (stealing), where there were so many clues and details that positioned itself as a favorable answer to the items 5 (why did he steal the wallet?) and 6 (What made you think of that answer?), it was not being very inviting of world knowledge. In fact, most respondents scored into the same category (text-implicit QAR), giving little information about that item. So there is a balance between the properties of the text, the degree to which it invites world-knowledge integration, the knowledge-base of the learner, and the manner in which they are all situated by the discourse context (e.g., purpose for reading, mood, level of interest).

IIR is also not specific to any particular type of modality or format; but that does not mean that the modality does not impact it. After all, I have argued throughout this work that processing disposition is always situated. In model 1, the main effect of comic format was negative, however including the self-rated comic experience variable in model 2, and model 3, the direction of the coefficient changes significantly. Experience is required to engage and improve in any form of literacy and comic plus text should be no different. The notion of the universality of comics must be demystified, and be used as the intervention, instead of merely included within an intervention, thus leaving comics on the periphery. The empirical evidence, (i.e., the banding of the levels/thresholds in the Wright Map and mean location increases across levels within items), support the hypothesized internal structure of IIR. Furthermore, the levels of IIR can be used to capture this construct (outcome space), even for non-inferential items, such as the meta-reasoning item (Why do you think so?). There is evidence supporting the external validity of IIR as well. This is based on the latent regression using diagnosis (autistic) as a predictor variable for having a significantly lower likelihood demonstrating relatively higher levels of IIR. This was expected based on the long line of theoretical and empirical work

suggesting that the local processing biases for autistic individuals dispose them not spontaneously integrate new experiences and information with their existing world knowledge (Frith, 2003; Frith & Happe, 1994; Happe & Booth, 2008; Happe & Frith, 2006).

However, even though the lower levels of IIR are less integrative, they are still inferences. Furthermore, there was heterogeneity within the autistic sample as well, so it is not as though adolescents on the autism spectrum are unable to achieve IIR, at any level. There is however a disposition towards being less spontaneously integrative when controlling for other variables (Model 1). The findings also support the notion of the ordinal relationship within the construct, ranging from low integration to relatively higher levels of integration. The lower levels of IIR align with local coherence, and the upper levels align with global coherence. In the context of IIR, ordinal relations do suggest this is a compensatory model; that is, when one is more integrative, they are relatively using more global processing skills, than when they are less integrative, relying more of local processing skills. Although the skill sets may be multidimensional, their use in constructing IIR were used unidimensionally.

Assessment, Curriculum, and Pedagogy

Is the evidence for the claims I have made about IIR, local vs. global processing, and the role of comics in supporting text, strong enough to suggest possible alterations in the assessment, curricular and pedagogical repertoires we offer students in our schools? The answer is yes. Educators are in a unique position where they see their students day in and day out, and are responsible for cultivating their educational development. IIR can serve as a road map to position students' responses on the IIR scale, further taking note of what material and context brings out their IIR, while at the same time building off of their responses and scaffolding them up the scale. Since capturing disposition is somewhat of a moving target, the IIR taxonomy serves as a guide in illuminating the positionality of the respondent for that given context.

IIR also suggests the value of trying to capture students' dominant dispositions, rather than simply achievement. Educators are often surrounded by high stakes testing, where achievement and accountability are the coin of the realm. If students do well, they are deemed to have more ability and schools can receive more funding. This can lead to teachers teaching to a test, being consumed with an achievement mindset. In which case, any time a learner cannot do something, they are painted with a deficit lens. Rather, seeing learning in the context of situated dispositions, educational materials can be developed with the idea of bringing out one's potential by situating their learning, and focusing on the context rather than the learner as the key issue.

Final word

This project has been a journey. There have been many iterations across Wilson's (2005) building blocks, and within each building block. Initially, the construct under investigation was seen in terms of coherence, ranging from local to global. Over time, the scale evolved to take into account more variations in inferential reasoning and levels of integration with prior knowledge.

Over time and in response to new data and analyses, a new framework emerged, including Kitnsch's (1988) construction integration theory. Now, in addition to incorporating level of coherence, the construct levels (text-implicit & script-implicit QARs) were held together by degree of integration. Incorporating Kintsch's framework now gave room for those respondents engaging in both local and global processing, as a third level that represented more explicit integration. Graesser's et al., (1994) inferential thinking model was also used to illuminate the construct, looking a subinferences that could work together with this new construct map.

The item design stayed relatively stable, but the outcome space was heavily modified over the iterations. Initially, when the combination category (category 3) was introduced, students only qualified for this category based on including ‘and’ as a connector between clauses that represented at least one local and one global representation. This limited the amount of people scoring into the category, leaving relatively low frequency counts. But a closer look at the responses revealed that respondents were using different connectors to link global and local clauses. Over time, using different lenses for examining particular lines of reasoning led to an expansion in the different ways students could integrate responses.

In the final analysis, perhaps the most significant outcome of the work is to reconsider and expand our thinking about the thinking of autistic learners. The findings of this study imply that autistic individuals have the same inherit drive as neurotypical peers to integrate their world knowledge with a narrative. Their capacity for integration appears to be situated differently. This is why it is important to see cognition not as a static set of skills, but rather as a set dynamic, situated operations. With practice comes experience, with experience comes knowledge, with knowledge comes deeper comprehension, which in turn promotes cognition. This line of research provides alternate frameworks, outside of the deficit model and within a neurodiversity lens, for thinking about autism and narrative meaning making.

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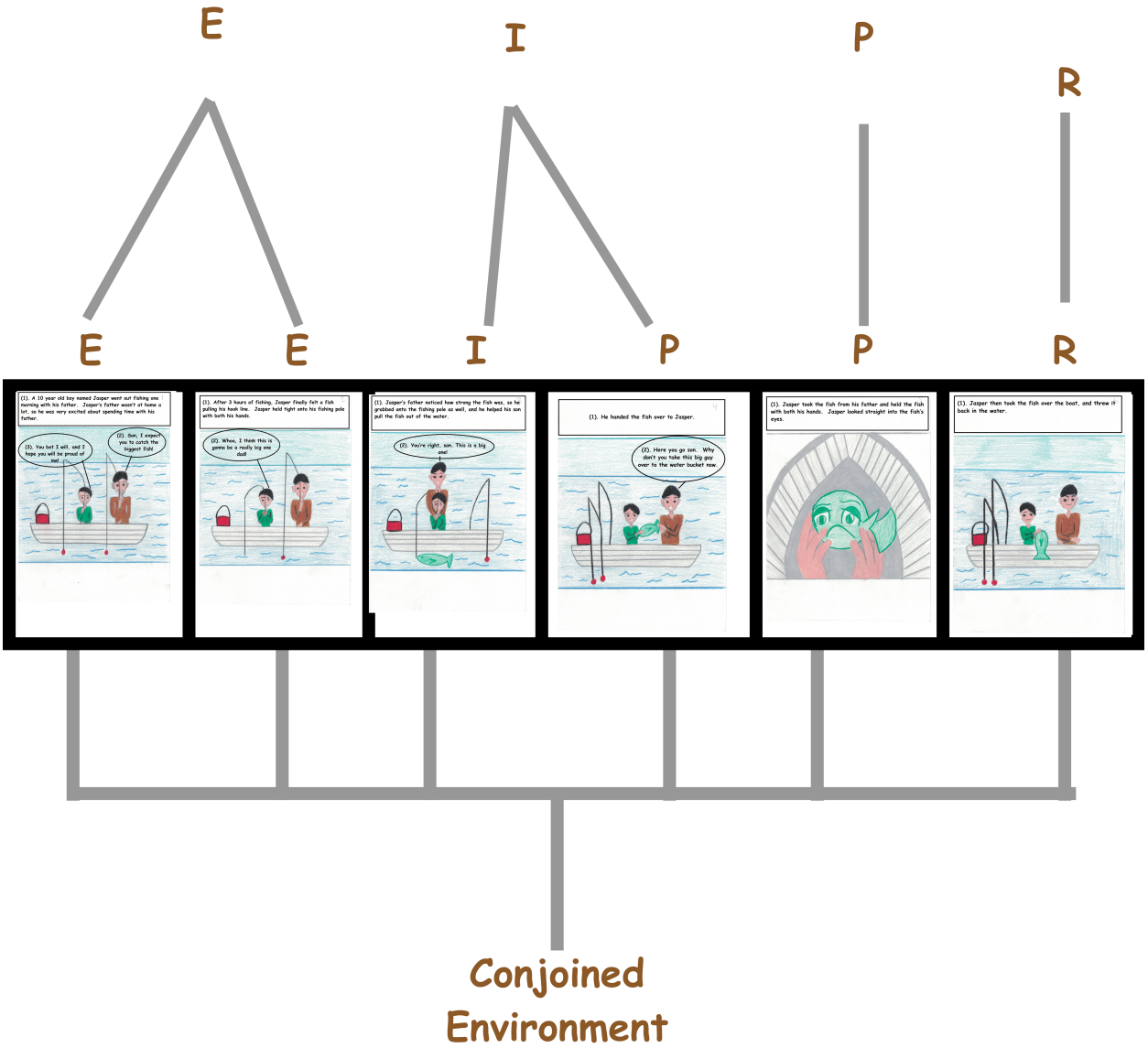
Appendices

Appendix A: Story 1-Fishing Phase 1



Appendix B: Story 2-Soccer Phase 1

There was a girl named Lacey who was the best at playing soccer. She was the team captain in her soccer team. Everybody loved Lacey because she scored many goals that won her team the games (Goals are points in a soccer game). "Go Lacey! You're the best!" The crowd cheered as she made a goal.

But the crowd never seemed to ever cheer for this other girl on the soccer team, named Ashley because they didn't think she was good. "Ashley, you're not being quick enough! You're letting them dribble the ball right past you!" Yelled the coach.

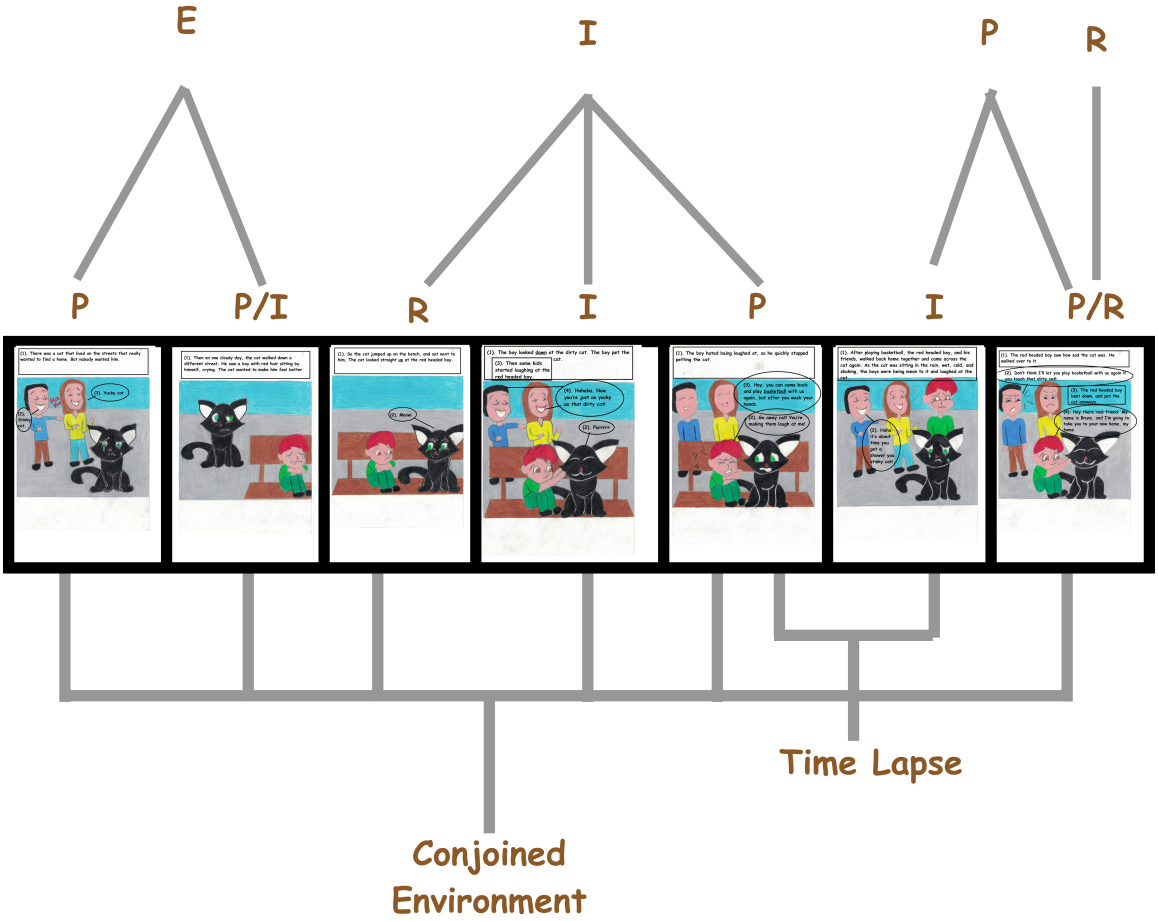
"Ashley, pass the ball to me!" said Lacey to Ashley. Ashley then passed the ball to Lacey.

Lacey scored a difficult goal. The crowd cheered for her. "Yeahhh!" yelled the crowd.

Then on one Saturday game, Lacey's team was tied with the other team. There was just a few seconds left in the game, and someone had just passed the soccer ball to Lacey. Lacey turned her head and saw Ashley, open. "Hey, pass the ball to me. I'm open!" said Ashley.

"Ashley, you're not good enough," thought Lacey to herself. So, Lacey kicked the ball and made the winning goal instead.

Appendix C: Story 3- Cat Comic Format Phase 2



Appendix D: Story 3-Cat Text Version Phase 2

There was a cat that lived on the streets that really wanted to find a home. But nobody wanted him. “Stinky cat”, said one boy to the cat. “Yucky cat”, said a girl to the cat.

Then on one cloudy day, the cat walked down a different street. He saw a boy with red hair sitting by himself, crying. The cat wanted to make him feel better.

So the cat jumped up on the bench, and sat next to him. The cat looked straight up at the red headed boy and said “Meow”.

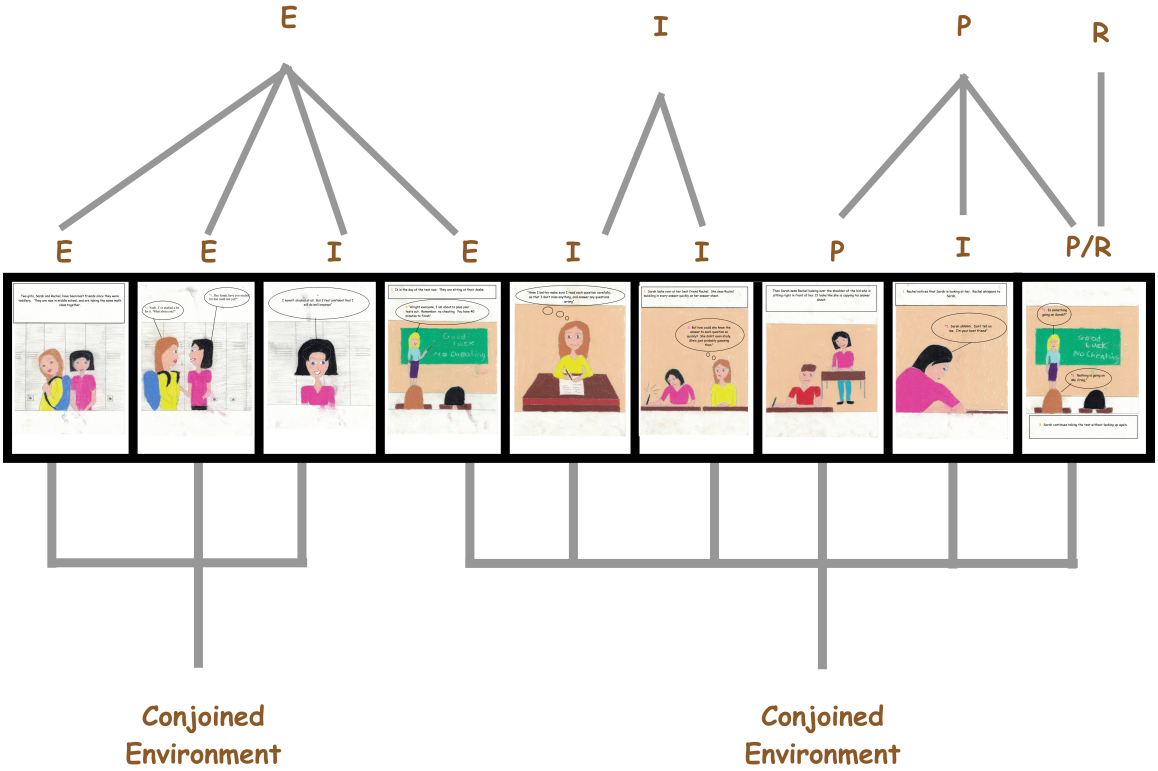
The red headed boy looked down at the dirty cat and then began to pet the cat. The cat said “purrrrr”. Then some kids started laughing at the red headed boy. “Hahaha. Now you’re just as yucky as that dirty cat” shouted one of the kids.

The boy hated being laughed at, so he quickly stopped petting the cat. The red headed boy shouted at the cat, “go away cat! You’re making them laugh at me!” “Hey, you can come back and play basketball with us again, but after you wash your hands” shouted a boy.

After playing basketball, all three of them walked back home together and came across the cat again. As the cat was sitting in the rain, wet, cold, and shaking, the boy and girl were being mean to it and laughed at the cat. “Haha it’s about time you get a shower you stinky cat!” said the boy. The red headed boy began to feel bad for the cat.

The red headed boy saw how sad the cat was. He walked over to it. “Don’t think I’ll let you play basketball with us again if you touch that dirty cat”, said the boy. The red headed boy bent down, and pet the cat anyways. Then, the red headed boy said to the cat, “hey there real friend. My name is Bruno, and I’m going to take you to your new home, my home”.

Appendix E: Story 4-Cheating Comic Version Phase 2



Appendix F: Story 4-Cheating Text Version Phase 2

Two girls, Sarah and Rachel, have been best friends since they were toddlers. They are now in middle school, and are taking the same math class together.

"Hey Sarah, have you studied for that math test yet?" asked Rachel. "Yeah. I've studied a lot for it. What about you?" asked Sarah.

"I haven't studied at all. But I feel confident that I will do well anyways", said Rachel.

It is the day of the test now. They are sitting at their desks. "Alright everyone, I am about to pass your tests out. Remember, no cheating. You have 40 minutes to finish", says the teacher.

Sarah says to herself, "Hmm I better make sure I read each question carefully, so that I don't miss anything, and answer any questions wrong".

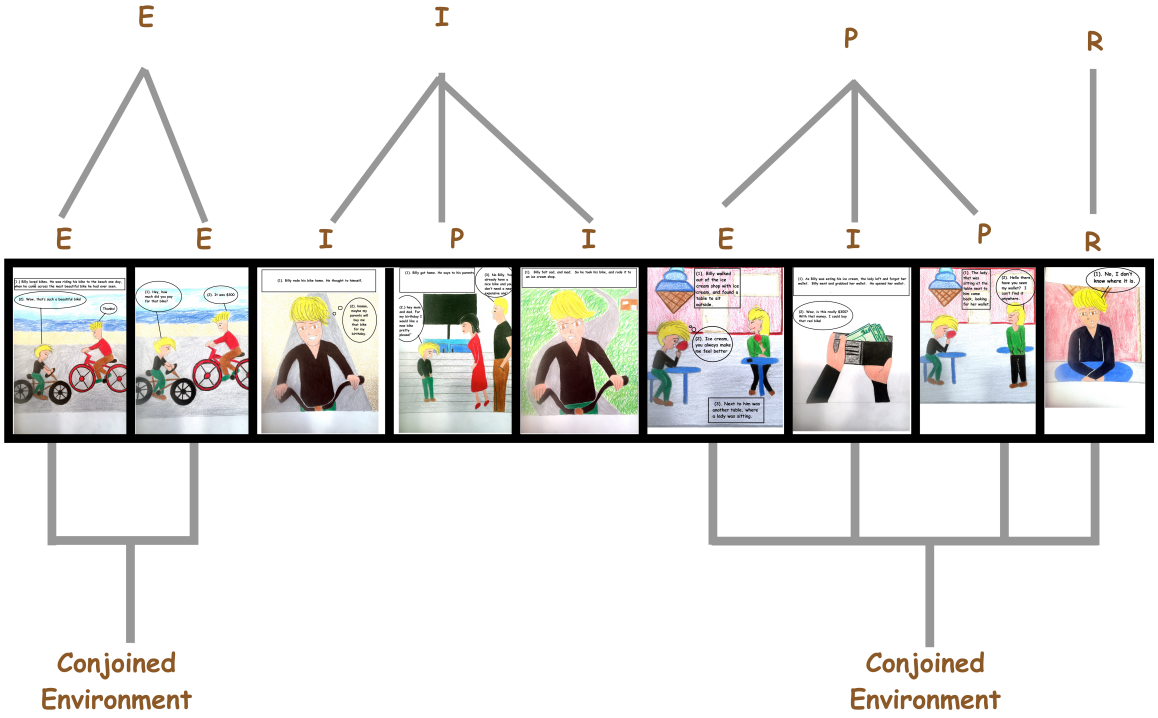
Sarah looks over at her best friend Rachel. She sees Rachel bubbling in every answer quickly on her answer sheet. Sarah says to herself, "But how could she know the answer to each question so quickly? She didn't even study. She's just probably guessing then."

Then Sarah sees Rachel looking over the shoulder of the kid who is sitting right in front of her. It looks like she is cheating by copying his answer sheet.

Rachel notices that Sarah is looking at her. Rachel whispers to Sarah, "Sarah shhhhh. Don't tell on me. I'm your best friend".

"Is something going on Sarah?" asks the teacher. "Nothing is going on Ms. Craig," answers Sarah. Sarah continues taking the test without looking up again.

Appendix G: Story 5-Stealing Comic Version Phase 2



Appendix H: Story 5-Stealing Text Version Phase 2

Billy loved bikes. He was riding his bike to the beach one day, when he came across the most beautiful bike he had ever seen. He said to the boy that was riding the beautiful bike, "wow, that's such a beautiful bike!" "Thanks!" said the boy.

"Hey, how much did you pay for that bike?" asked Billy. "It was $300", answered the boy.

Billy rode his bike home. He thought to himself, "hmmm, maybe my parents will buy me that bike for my birthday".

Billy got home. He says to his parents,"hey mom and dad. For my birthday I would like a new bike pretty please!". "No Billy. You already have a nice bike and you don't need a new expensive one", said his father.

Billy felt sad, and mad. So he took his bike, and rode it to an ice cream shop.

Billy walked out of the ice cream shop with ice cream, and found a table to sit outside. "Ice cream, you always make me feel better" Billy said to himself. Next to him was another table, where a lady was sitting.

As Billy was eating his ice cream, the lady left and forgot her wallet. Billy went and grabbed her wallet. He opened her wallet. "Wow, is this really $300? With that money, I could buy that red bike!" Billy said. Billy decided to keep her wallet.

The lady that was sitting at the table next to him came back, looking for her wallet. She said, "hello there, have you seen my wallet? I can't find it anywhere."

"No, I don't know where it is", said Billy.