Ursidae: The Undergraduate Research Journal at the University of Northern Colorado

Volume 4
Number 2 *McNair Special Issue*

Article 13

January 2014

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Pamela Wagoner

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Pamela Wagoner, Audiology & Speech Language Sciences
Mentor: Kimberly Murza, Ph.D., Audiology & Speech Language Sciences

Abstract: Although the foundational cognitive and linguistic skills of generating inferences in both reading and social contexts are similar, relationships between these two modalities, and with empathy, are unclear and have not been thoroughly studied. These relationships were explored by testing 30 typically developing college students' ability to generate social inferences in the Eyes Test (Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001) and Voice Test (Golan, Baron-Cohen, Hill, & Rutherford, 2007), ability to generate reading inferences in the Inference subtest of the *Watson-Glaser Critical Thinking Appraisal* (Watson & Glaser, 1964), and their capacity for empathy from the Empathy Quotient (Baron-Cohen & Wheelwright, 2004), as well as considering a number of demographic variables (e.g., age, gender, and major). No significant relationships were found between social inference scores and reading inference scores or between composite inference generation scores and empathy, age, gender, or major. Findings from this study are a critical first step for practitioners hoping to assist individuals with deficits in inference generation.

Keywords: *empathy, reading inference, social inference*

Both social inference and reading inference generation involve a person taking what he or she already knows and applying it to the situation to make an educated guess (Graesser & Kreuz, 1993; Loukusa & Moilanen, 2009; Magliano & Graesser, 1991). Inferences are generated when a person combines background knowledge with contextual information. The contextual information may be nonverbal cues from a speaker or written information provided in a text. A listener considers the speaker's intonation, facial expressions, body language, and other nonverbal cues to determine the speaker's message. This is referred to as social inference generation (Loukusa & Moilanen, 2009). It is important that a person generates inferences about their conversational partner to know things like when they are being sarcastic, become uncomfortable, or are ready to move to a different topic. Similarly, reading inference requires an activation of world knowledge during text comprehension (Graesser & Kreuz, 1993; Magliano & Graesser, 1991). A reader must generate inferences while reading in order to comprehend the text, understand an author's intent, or make an assumption about the information they have read. Although there is a range of normal, most people effectively generate inferences in both modalities on a daily basis. If no deficits are present, these tasks are completed easily and without much conscious effort.

Based on current literature, it is known that certain groups of people have difficulties with both types of inferences. Outside of the variation within a normal population, studies have consistently found that individuals with high functioning autism spectrum disorder (HFASD) struggle with both social inference and reading inference generation (Baron-Cohen, Jolliffe, Mortimore, & Robertson, 1997; Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001; Golan, Baron-Cohen, Hill, & Rutherford, 2007; Loukusa & Moilanen, 2009; Roeyers, Buysse, Ponnet, & Pichal, 2001; Smith Myles et al., 2002; Sourn-Bissoui, Caillies, Gierski, & Motte, 2009), especially when required to attribute mental states to characters in stories according to the contextual information given (Happe, 1994; Heavey, Phillips, Baron-Cohen, & Rutter, 2000; Jolliffe & Baron-Cohen, 1999; Kaland et al., 2002; Kaland et al., 2005). An increasing number of reports suggest autism spectrum disorder (ASD) has reached 1% of the population within the United States and other countries in both children and adults (American Psychiatric Association, 2013). These individuals' academic success and social

lives may be affected by deficits in inference generation. Many individuals with HFASD have reported difficulties in maintaining relationships and engaging in social settings because of their social deficits (Baron-Cohen & Wheelwright, 2004; Tager-Flusberg, 1999). For example, difficulties with understanding non-literal messages and intended meaning have been found to impact peer interactions and friendships of those with HFASD (Tager-Flusberg, 1999).

In order to improve inference generation in those that have deficits in this area, it may be beneficial to first explore more about social inference and reading inference generation in general. It is known that the processes involved and the foundational cognitive/linguistic skills of generating inferences in both contexts are similar. However, it is unclear whether there is a relationship between the two modalities of inference generation. Are social inference and reading inference generation related? Without this foundational knowledge, it is difficult to intervene with individuals who have problems with inference generation. If a relationship exists within a typically developing population, researchers might next investigate what that relationship looks like in individuals with HFASD. The purpose of this study is to explore whether a relationship exists between inference generation in two modalities within a typically developing population. Additionally, this study explored whether inference generation is related to empathy scores as well as demographic variables (e.g., age, gender, and major/field).

Foundational research, such as that conducted in this study, may serve to provide necessary information for practitioners and researchers interested in helping individuals who have difficulty generating inferences. Additionally, clinicians may benefit from knowing if gender, age, major, or empathy are related to a person's inference ability when creating treatment plans or deciding if someone is a good candidate for intervention. For example, if it is found that older individuals are better at generating inferences, clinicians may expect lower inference scores from a very young client compared to an older client.

The findings of this study provide information about social inference and reading inference in general, which may be applicable to a typically developing population, as well as those with autism or other disabilities.

BACKGROUND

Cognitive and Linguistic Underpinnings

Cognitive and linguistic underpinnings of inference generation include pragmatic language, theory of mind, and empathy. Pragmatic language is simply using language in context and in social situations including the functions, purposes, and intents of communication (Hulit & Howard, 2006; Loukusa & Moilanen, 2009; Roseberry-McKibbin, 2007). The meaning of a word or sentence may be different from one situation to another depending on how it is used and what context it is used in. Pragmatic skills are used to relate a text or dialogue to the context of the rest of the text or conversation. While pragmatic skills are constantly used to generate inferences in social situations, they are also used to generate inferences while reading. A reader uses the context of a text to understand the meaning of individual words or phrases used within that text. Pragmatic language is also involved when reading about people and their interactions to understand intentions or basic communicative interactions.

In addition to pragmatic language, understanding that other people have thoughts and opinions different from their own is a foundational skill for individuals when engaging in conversations and understanding motives and emotions of other people (Baron-Cohen et al., 1997; McDonald et al., 2006; Tager-Flusberg, 1999). This skill is called theory of mind and is sometimes referred to as "mentalizing" or "mind reading" (Baron-Cohen et al., 1997; Baron-Cohen et al., 2001; Golan & Baron-Cohen, 2006; Happe, 1994) because it involves thinking about another person's mind. Different levels of theory of mind have been explored. First-order theory of mind involves inferring another person's thoughts. Typically developing four year-olds are able to pass most tests of first-order theory of mind (Baron-Cohen et al., 1997). Second-order theory

of mind is a slightly more complex skill that involves inferring what one person thinks about another person's thoughts. Typically developing six year olds generally pass second-order theory of mind tests (Baron-Cohen et al., 1997).

Regardless of the level, theory of mind is a foundational skill of inference generation (Pijnacker, Hagoort, Buitelaar, Teunisse, & Geurts, 2009). Theory of mind is involved when generating social inferences but only for certain types of reading inferences (Graesser & Kreuz, 1993; Magliano & Graesser, 1991). For example, when a reader generates an anaphoric inference, they infer what the word *it* is referring to within that sentence. This type of inference generation does not involve theory of mind because it is not necessary for the reader to acknowledge the thoughts of another person.

Empathy. Empathy has certain similarities to theory of mind and inference generation, depending on the context and definition of empathy. Many authors acknowledge that there are two components to empathy: cognitive and affective (Adams, 1983; Baron-Cohen & Wheelwright, 2004; Eisenberg & Lennon, 1983; Ickes, 1993; Roeyers et al., 2001). Empathy that involves the cognitive component of recognizing the thoughts, emotions, or intentions of another person has been identified as cognitive empathy. The emotional or behavioral response to another person's emotions is referred to as affective empathy. Most studies focus on testing one or the other type of empathy. With this distinction between the two types of empathy, it makes sense that some literature uses cognitive empathy and theory of mind as interchangeable terms because both include perspective taking and recognizing another person's thoughts (Roeyers et al., 2001; Baron-Cohen et al., 1997). Thus, it is important to indicate which type of empathy is being tested. This study will follow the definitions given by Roeyers et al. (2001) and will refer to cognitive empathy as theory of mind. When speaking of affective empathy, this study will refer to empathy, plainly. In this sense, theory of mind is an acquired skill; whereas, empathy is a characteristic trait.

Some authors have studied demographic variables such as gender, major and age in relation to empathy. Adolescent and adult females have been found to score higher on empathy tests compared to males in some literature (Adams, 1983; Baron-Cohen et al., 1997; Baron-Cohen & Wheelwright, 2004; Harton & Lyons, 2003; Lawrence, Shaw, Baker, Baron-Cohen, & David, 2004). These findings are consistent with that of Baron-Cohen and Wheelwright (2004) in their development of the Empathy Quotient (another name for the Cambridge Behaviour Scale). However, a review by Eisenberg and Lennon (1983) found the technique used to test empathy is an important factor in considering whether gender differences exist. Females tend to self-report higher scores of empathy than males. However, these reports do not consistently match other measures of empathy such as facial, vocal, and gestural measures of empathy (Eisenberg & Lennon, 1983). Other studies have found higher empathy scores with increased age (Adams, 1983) as well as in students with a psychology major or minor (Harton & Lyons, 2003).

Lawrence et al. (2004) studied relationships similar to those that were explored in this study: social inference and empathy. These authors found questions related to social skills on the Empathy Quotient were significantly correlated with performance on the "Reading the Mind in the Eyes" test, also referred to as the Eyes Test (Baron-Cohen et al., 2001). Although this is a close approximation of what the present study explored, the Eyes Test was the only test of social inference used by Lawrence et al. (2004); whereas, the present study compared two tests of social inference as well as one test of reading inference.

Social Inference Generation

Although there are many parallels between social inference and reading inference generation, they are still very different. Inference generation in reading is a static task but social inference generation is dynamic. Inferences are generated in social situations by using pragmatic skills to combine background knowledge with what a

speaker says and how they say it (Loukusa & Moilanen, 2009). While listening to the actual words, a listener must also pay attention to the nonverbal communication of the speaker to understand the message. The listener combines their world knowledge with the speaker's message to make an educated guess about the speaker's intentions or emotions. For example, an individual may use their background knowledge of another person's distaste for dancing, along with her intonation, to infer that she was being sarcastic when saying she had fun at the dance.

Social inference generation has been tested through emotion recognition tests involving static images of eyes, voice clips, or a video of people interacting. The Eyes Test (Baron-Cohen et al., 2001) is a social inference test in which participants look at an image of a human face that has been cropped down to a rectangle around the eyes and choose the emotion that person is feeling. In this case, the only contextual information given is the facial expression of the person. Although the Eyes Test was developed for individuals with HFASD, it has been revised and shown to be a valid and reliable test for typically developing people, as well as those with disabilities (Baron-Cohen et al., 1997; Baron-Cohen et al., 2001; Golan et al., 2007; Lawrence et al., 2004). To ensure that poor scores on the Eyes Test could actually be attributed to deficits in social inference, simple control tests were administered to ensure participants could recognize gender and basic emotions in pictures of human faces. Because this test requires participants to think about the thoughts of another person, the ability to perform well on this task indicates an intact theory of mind.

The "Reading the Mind in the Voice" test, also referred to as the Voice Test, developed by Golan et al. (2007), is another test of social inference that requires participants to rely fully on nonverbal features as they listen to a short voice clip of a person and determine the emotion of the speaker, without any other contextual information about the actual message. After listening to the voice clip, participants chose what emotion the person is feeling from a list of four options. Again, the Voice Test was designed for individuals with HFASD, but has been revised to eliminate a ceiling effect to make it useful for testing typically developing people (Golan et al., 2007).

Some studies have sought to find a more naturalistic test of social inference by showing participants a video of people interacting. In a study conducted by Roeyers, Buysse, Ponnet, and Pichal (2001) participants were asked to identify what people in a video were thinking and feeling at various times. The Awareness of Social Inference Test (TASIT) assesses individuals' ability to recognize basic emotions, judge sincerity and sarcasm, and decipher intended meanings of what someone says (McDonald, Bornhofen, Shum, Long, Saunders, and Neulinger, 2006). Typically developing participants scored at or above 84% on the tasks in the TASIT. These tests are examples of a more dynamic assessment measure of social inference although, typically developing people were, again, only tested as a control group.

One study (Adams, 1983) assessed theory of mind and empathy in typically developing adolescents in relation to social situations. Participants were tested on their understanding of and reaction to others' emotions, essentially testing empathy and social inference. Higher empathy scores were found with increased age. Studies such as this one are not as common as those that focus on individuals with disabilities, such as those with HFASD. Beyond revising and validating tests, typically developing people are not as often studied in their ability to generate inferences, except as a control group. A lack of research in social inference generation is evident, and even more so within a typically developing population.

Reading Inference Generation

Similar to inferences generated in social situations, a person may generate an inference about the thoughts, motivations, and emotions of a character in a story by combining world-knowledge with contextual information given in the text (Graesser & Kreuz, 1993; Magliano &

Graesser, 1991; Loukusa & Moilanen, 2009). Graesser and Kreuez (1993) and Magliano and Graesser (1991) have described 11 different types of reading inferences that can be generated while reading. Some inferences are activated by local interpretation of text elements, whereas others are activated by global understandings of the passage. For example, an anaphoric inference is generated to determine the antecedent to a referent (e.g., what the word *it* is referring to in a sentence) and is generated through interpretation of local information given in the text. In contrast, generating an inference about the author's intent of a story is an example of a global inference because the reader must draw on information not stated in the text along with what they read. In addition, the reader must be able to think about the author's thoughts and, therefore, demonstrate theory of mind.

Inferences generated about the emotions or motivations of characters are also global inferences. When generating inferences about another person's feelings or emotions, theory of mind is involved because it requires a person to attribute thoughts and feelings to another individual (Baron-Cohen et al., 1997; McDonald et al., 2006; Tager-Flusberg, 1999). Although some inferences are generated without using theory of mind, all types of reading inferences require the reader to contribute world knowledge to the textual information (Graesser & Kreuz, 1993). When reading narrative text, a reader may generate inferences about a character's emotions by reading about the events taking place, the actions of the character, and other characters involved while combining it with information, such as personal experiences. A reader may also generate inferences to answer underlying questions about the major point of the text, the moral message, or the reason the author included certain information.

Researchers have studied individuals' ability to generate inferences while reading, including attributing mental states to characters in stories according to the contextual information given (Happe, 1994; Heavey et al., 2000; Jolliffe & Baron-Cohen, 1999; Kaland et al., 2002; Kaland et al., 2005). For example, Happe's (1994) Strange Stories test contains short stories about a person or groups of people that requires readers to make global inferences. There were twelve types of stories including Lie, White Lie, Joke, Pretend, Misunderstanding, Persuade, Appearance/Reality, Figure of Speech, Sarcasm, Forget, Double Bluff, and Contrary Emotions. Though the typically developing control group was able to attribute appropriate mental states to characters, there was a range of scores within the group. When asked "why" a character did or said something, the typically developing participants made more mental state justifications than physical state justifications, suggesting the use of theory of mind. Typically developing individuals assessed in this study were only part of a control group and were not the main focus of this study. Another test of reading inference is the Inference subtest of the *Watson-Glaser Critical Thinking Appraisal* (Watson & Glaser, 1964), which requires the reader to make assumptions about people and events based on what they already know and what they read in a short passage. Other tests developed for individuals with HFASD assess individuals' ability to generate local inferences from just a few sentences (Sourn-Bissoui et al., 2009; Smith Myles et al., 2002). Still, more research is needed within reading inference generation in both local and global inferences.

Although many studies have found deficits within individuals with HFASD, there is limited research about inference generation of both modalities within a typically developing population. Furthermore, the literature has yet to explore whether a relationship exists between social inference and reading inference generation. As discussed, there are similarities in social inference and reading inference generation and in the cognitive and linguistic underpinnings of inference generation. However, it is unclear whether the two types of inferences are just similar, or if they are in fact related. Understanding more about inference generation in general is a first step in understanding more about deficits in this area, for those with HFASD, and then how to address these issues. Exploratory

research, such as the present study, provides a foundation for further research exploring treatment and the implications for service delivery. By providing more information about inference generation in general, it may become clearer which direction is best for future research studying individuals with HFASD. Therefore, the following research questions were posed for the current study:

1. Is there a relationship between reading inference and social inference performance in typically developing college students?
2. Is there a relationship between empathy scores and inference performance in typically developing college students?
3. Are demographic variables such as age, gender, and major/field related to inference ability in typically developing college students?

METHODS

Participants

A total of 30 college students with no known cognitive deficits from a mid-sized university in the Rocky Mountain region volunteered to participate in this study. The ages of participants ranged from 18 to 45 years old. The majority of participants were between 18 and 22 years old (n = 23), with the remaining between 27 and 45 years old (n = 7). Majors were categorized into one of three groups because there were too many different majors to analyze individually (Table 1).

Materials and procedures

Following IRB approval, each participant completed one assessment session, individually or with a group. Sessions took approximately 30-60 minutes. Participants were assessed using four measures, including three assessments to test inference ability and one questionnaire to test empathy. The Voice Test (Golan et al., 2007) and the Eyes Test (Baron-Cohen et al., 2001) were used to assess social inference. Each test isolates one aspect of a person that a listener must pay attention to in a social interaction in order to generate an inference.

When taking the Voice Test, participants listened to a short voice clip of a person and then chose the appropriate emotion of the speaker from four possible emotions. No contextual information was provided so the participant had to rely on the nonverbal features of the person's voice. When taking the Eyes Test, participants were shown a photograph of a person's eyes and chose the appropriate emotion of the person shown.

Table 1. Different Majors Included in Major Categories

Major Category	Majors	*n*
Human and health sciences (HHS)	Audiology and Speech Language Sciences Psychology Human Services Higher Education and Student Affairs Recreation, Tourism, and Hospitality	16
Hard sciences	Environmental Science Biology Environmental/Sustainability Studies Meteorology	4
Humanities and social sciences (HSS)	Communications History Spanish Sociology Business Economics Art and Design	10

The Eyes Test requires the participant to focus on nonverbal language from the facial expression in the eyes to decide how that person is feeling. Participants were given one point for each correct answer on the Eyes Test and the Voice Test. There were 36 possible points on the Eyes Test and 25 possible points on the Voice Test. A list of definitions of emotions were provided and could be referred to at any time when taking the Eyes Test and Voice Test.

The Inference subtest of the *Watson-Glaser Critical Thinking Appraisal* (Watson & Glaser, 1964) was used to test reading inference ability. Participants read three short passages and privately answered the questions by indicating true or false for five or six statements about each passage. This assessment measure requires the reader to make assumptions about people and events based on what they already know and what they read in a short passage. One point was given for each correct answer with a total of 16 points possible.

The Empathy Quotient (or Cambridge Behaviour Scale), developed by Baron-Cohen and Wheelwright (2004), was used to measure empathy. The Empathy Quotient consists of 40 questions related to empathy and 20 filler items included to distract the participant from the explicit focus on empathy. The maximum score a participant could receive was 80 points.

Data analysis

Participant responses were scored according to the answer key provided for each assessment measure. Data was entered into SPSS. Scores from the Voice Test and the Eyes Test were combined as a composite social inference score. A Pearson correlation was used to analyze whether a relationship existed between the composite social inference score and the reading inference score, which addressed the first research question. A composite social inference score was computed by adding the correct number of responses from the Eyes Test with the correct number of responses on the Voice Test. Reading inferences scores were computed from the correct number of responses from the Inference subtest of the *Watson-Glaser Critical Thinking Appraisal.* Additionally, a composite inference score was found by combining the social inference scores and the reading inference score. A Pearson correlation was used to determine whether a relationship existed between the composite inference score and the empathy score to address the second research question. Finally, the third research question was addressed using two tests. To identify whether a relationship exists between the composite inference score and the person's age, a Pearson correlation was used. A chi-square test was used to explore whether a relationship existed between the composite inference score and the participant's major and gender separately.

RESULTS

A Pearson correlation was conducted to determine if a relationship existed between composite social and reading inference scores. No significant relationship was found ($r = .20$, $n = 30$, $p = .28$). Additionally, a Pearson correlation was used to determine if a relationship existed between composite inference scores and empathy scores; again no significant relationship was found ($r = -.19$, $n = 30$, $p = .31$). Mean scores of composite inference, composite social inference, reading inference, and empathy can be found in Table 2.

To answer the third research question, two tests were used. The results of the Pearson correlation suggested no significant relationship between composite inference scores and age ($r = .10$, $n = 30$, $p = .59$). The results of a chi-square test of association found no significant relationship between composite inference scores and gender ($\chi^2 = 22.33$, $df = 19$, $p = .27$) or between composite inference scores and major category ($\chi^2 = 35.16$, $df = 38$, $p = .60$). Mean scores of composite inference tests within each age category, gender, and major category can be found in Table 3.

Because composite inference and reading inference scores were not significantly related, additional tests were done to analyze composite social inference scores and reading inference scores separately but found no significant

relationships with empathy, age, gender, or major. However, the results of a chi-square test of association suggest gender and reading inference scores were approaching a significant relationship (χ^2 = 15.09, *df* = 9, *p* = .09). Composite social inference scores and gender were also approaching a significant relationship (χ^2 = 24.03, *df* = 19, *p* = .20).

Table 2. Group Performance on Assessment Measures.

Variable	*n*	*M*	*SD*	Total
Composite social inference	30	42.07	6.43	61
Reading inference	30	8.97	2.47	16
Composite inference	30			77
Empathy	30	50.10	11.13	80

Table 3. Composite Inference Scores within Different Demographics.

Demographics	*n*	*M*	*SD*	Range
Age Categories				
18-22	23	50.78	7.75	38-64
27-45	7	51.86	6.26	40-60
Gender				
Male	8	50.13	8.54	38-63
Female	22	51.36	7.05	39-64
Major Categories				
HHS	16	52.56	6.79	39-61
Hard sciences	4	46.75	6.85	39-53
HSS	10	50.30	8.26	38-64

DISCUSSION

No significant relationships were found between social inference and reading inference scores. Although it seems logical that the two modalities of inference generation are related, given the similar cognitive and linguistic skills required for both types of tasks, this study suggests that the two types of inference generation are two separate skills sets. These results are somewhat surprising but may be explained by the small sample size and assessment measures used. For example, the test used to assess reading inference is only a subtest of a larger test and is somewhat dated. There is a lack of resources for tests of reading inference, especially those that can be used on a typically developing population. For example, Happe's (1994) Strange Stories test is a valid test of reading inference generation, but was developed for individuals with social or cognitive deficits and therefore would not have provided enough variation among scores in this study on typically developing college students. A strength of the reading inference test used in this study (i.e., the *Watson-Glaser Critical Thinking Appraisal*, Watson & Glaser, 1964) was that it did not have a ceiling effect and scores varied greatly among participants.

The type of reading inferences assessed in this study may also explain this weak relationship. The Inference subtest of the *Watson-Glaser Critical Thinking Appraisal* (Watson & Glaser, 1964), used in this study, includes multiple types of reading inferences. Although the reader is required to use background knowledge to generate each inference, many of the tasks do not require the reader to use theory of mind or consider the emotions of another person. Perhaps a different task would have revealed a stronger correlation between social inference and reading inference. Happe's (1994) Strange Stories test includes more reading inferences having to do with social and emotional responses, which may be related to social inference more than what was found in this study.

The tests of social inference used in this study also warrant further investigation of how well they assessed an individual's ability to generate inferences in actual social situations. Anytime a social situation is replicated, whether in an assessment measure or in a clinical setting, it lacks certain aspects of a natural social interaction. For example, during a natural conversation, an individual usually has more than one opportunity to read nonverbal cues to generate an inference about the emotion of their conversational partner. A social interaction is also more dynamic in that the speaker and listener roles are constantly changing and more

information is being provided as the conversation progresses. A listener can often use information they previously knew about that person or situation to help generate an inference as well. Both the Eyes Test (Baron-Cohen et al., 2001) and the Voice Test (Golan et al., 2007) are much more static and isolated. It is possible that a more dynamic test of social inference would unveil more of a relationship between social inference and reading inference, though one has not yet been designed that would be valid for a typically developing population. Despite their static nature, both the Eyes Test and Voice Test have been proven to be valid tests of social inference generation that revealed no ceiling effect and produced a variety of scores among participants in this study.

Although contrary to what was expected, these results provide important information that has not been previously studied. By defining the relationship between social inference and reading inference, practitioners can incorporate these findings into service delivery and researchers may have a better idea as to where to direct future research. The findings of this study are important for practitioners, specifically those who work with individuals with deficits in inference generation. Although neither improvement in inference generation nor transferability of these skills were tested in this study, the findings do suggest that inference skills across modalities are not related which implies that improvement in one modality would probably not cause improvement in the other. For example, speech language pathologists may hope that improvement in reading inference abilities will generalize to social situations, but this might not be the case. Practitioners should use great caution when making assumptions about the generalization of skills across the two inference modalities.

In relation to empathy, no statistical correlation was found between composite inference scores and empathy scores indicating that inference generation and empathy are also different skill sets or characteristics. As discussed earlier, definitions of empathy have often been inconsistent across the literature (Adams, 1983; Baron-Cohen & Wheelwright, 2004; Eisenberg & Lennon, 1983; Ickes, 1993; Roeyers et al., 2001). Although some definitions of empathy are similar to social inference and certain types of reading inferences (Eisenberg & Lennon, 1983; Lawrence et al., 2004), this study measured empathy through a self-reported questionnaire while measuring social inference generation in isolated but realistic contexts. The two varied ways of measuring empathy and inference may have influenced the outcomes. The Empathy Quotient required the participants to report on their perceptions of themselves in relation to social situations and their reactions to other people's ideas. This type of self-reporting measure raises the question: how different are individuals' perceptions of themselves compared to their actual performance in real situations? It could be that participants viewed themselves as better or worse at reacting to and understanding the emotions of another person, yet could not accurately decipher the emotions of someone when presented with the tests of social inference used in this study, which supports previous research done on various ways of testing empathy (Eisenberg & Lennon, 1983). Results from this study may also indicate that a person's ability to empathize with someone does not necessarily mean they can accurately identify the emotions of another person or perform better in reading inference tasks that require them to think about other people's motivations or the author's intent. Either way, it is important to know that empathy and inference ability, as tested in this study, are not significantly correlated.

Additionally, results indicated that a person's age, gender, and major are not significantly related to an individual's performance on all the other inference generation tasks. Again, these results were unexpected but may be explained by the lack of diversity among participants and small sample size in each demographic group. Males, students in hard sciences, and participants 27 years or older were underrepresented in this study due to the fact that participants were recruited from a convenience sample. A stronger

correlation may have been seen in each demographic with more participants to analyze.

Even when reading inference and social inference were analyzed separately, no significant relationships were found between either type of inference and age, gender, or major. Still, relationships approaching significance were found between inference generation and gender and some variation can be seen in performance across age and majors, although not statistically significant. Gender differences have been found in relation to empathy (Eisenberg & Lennon, 1983), but gender differences on social inference tasks have not been studied. Therefore, it is difficult to explain why these results were found. The same is true of age and major differences. Researchers have studied empathy and age (Adams, 1983) and empathy among different majors (Harton & Lyons, 2003), but no researchers have examined these demographics and inference generation.

Slight variations in age and majors found in this study may be significantly different with a larger sample size. The 27-45 age category had a smaller range of scores compared to the 18-22 age category. The mean composite inference scores within hard sciences and humanities and social sciences were lower than human and health services, with the top scores among those in hard sciences below the mean of human and health services. The majors categorized in the human and health sciences group generally lead to professions that involve working directly with people and providing services of some kind for people in need. This may indicate why scores were slightly higher among those in "helping" professions. These individuals may be slightly better at generating inference in a social situation because of explicit teaching about human behaviors or because they have more experience interacting and inferring the emotions of an unfamiliar person. Reading is also very different in hard sciences and typically requires the reader to make fewer inferences about motivations, intentions, or emotions. Conversely, when reading about humans, as students in human and health services and humanities and social sciences typically do, a reader is generally required to consider the feelings and emotions of the individual they are reading about. Still, more research is needed to make more solidified claims.

Future Research

Future research should include more participants with more diverse demographics. A larger number of participants that is more representative of the population as a whole would increase the validity of the findings. One way to achieve this would be to assess the inference ability of children, or adults who are no longer in college. It may also be beneficial to explore the relationship between inference ability and ethnicity to assess whether culture has anything to do with inference. Further research is definitely warranted among individuals with HFASD and how to improve social and reading inference generation. Researchers should also consider taking a closer look at the assessment measures used to assess inference ability and empathy. Although it is difficult to replicate a naturalistic social interaction in a clinical setting, it would be beneficial to find a more dynamic and realistic way to assess an individual's ability to generate inferences in social situations. Future research may also explore better ways to assess empathy and find a way to verify self-reports with actual performance of participants.

Conclusion

This study tested 30 typically developing college students between the ages of 18 and 45 years old and found that social inference and reading inference tasks are different skills that are not significantly related to one another. Additionally, empathy and inference generation were found to be different skills or characteristics that were also not significantly related. Although gender and inference generation were approaching significant relationships, neither age nor majors were significantly related to performance on inference generation tasks. This study provides foundational information on a topic that has not yet been thoroughly researched. Findings are important for practitioners working with individuals with deficits in inference generation, such as those with HFASD. By finding that

inference generation across the modalities are not related, practitioners may have a better understanding of how to address each aspect of inference generation. Moreover, researchers are presented with future directions in studying inference generation in those with deficits and those who are typically developing.

ACKNOWLEDGEMENTS

This research was supported in part by grants from the Natural and Health Sciences Student Research Fund and from the Audiology and Speech Language Sciences Research Committee.

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