

Mental State Verb Use by Children with Fragile X Syndrome

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### **Abstract**

Mental state verbs are an important component of social interactions and are often delayed in impaired populations. In this study, mental state verb use by children with fragile X syndrome was examined during spontaneous conversations of 52 children and their mothers. Mental state verb use was related to measures of receptive and expressive language and developmental abilities. Mothers' use of mental state verbs and children's autistic behaviors were not related to children's use of mental state verbs. The results suggest that specific pragmatic impairments in fragile X syndrome influence the use of mental state verbs regardless of the presence of autistic behaviors.

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Fragile X syndrome (FXS) is the most common inherited cause of intellectual disability (Crawford, Acuna, & Sherman, 2001). Several studies have examined the general language profile of children with fragile X syndrome (FXS) (e.g. Abbeduto, Brady, & Kover, 2007; Abbeduto & Hagerman, 1997; Finestack, Richmond, & Abbeduto, 2009), as well as the expressive language abilities of individuals with FXS (e.g. Belser & Sudhalter, 2001; Mazzocco et al., 2006; Roberts, Hennon, et al., 2007). However, very few studies have examined specific lexical terms or categories such as relational terms (*bigger, shorter*), deixism (*this, that*), or mental state verbs (*think, know*). Using mental state verbs is an important skill for successful social interactions (Baron-Cohen, 1995; Tager-Flusberg, 1992), which are known to be problematic for children with FXS (Abbeduto et al., 2007) and autism (Tager-Flusberg, 2000). The purpose of the current study was to examine the use of mental state verbs in the spontaneous speech of children with fragile X syndrome.

### **Fragile X Syndrome**

Fragile X syndrome occurs in about 1 in 4000 males and about 1 in 8000 females (Abbeduto & Murphy, 2004; Crawford et al., 2001). Although FXS affects both genders, males usually exhibit a more severe disability because the syndrome results from an expansion of a gene on the X chromosome (Crawford et al., 2001; Price et al., 2008). Autistic behaviors are highly comorbid with FXS, and many children with FXS are also diagnosed with an autistic spectrum disorder (Clifford et al., 2007; Hatton et al., 2006). The physical characteristics of FXS include a long face, large ears, macroorchidism, flat feet, and loose joint tissue (Abbeduto & Hagerman, 1997). Behavioral traits of fragile X syndrome include hyperactivity, short attention span, impulsivity, poor eye contact, hypersensitivity, poor inhibitory control, shyness, anxiety,

social withdrawal, and other autistic behaviors (Abbeduto et al., 2007; Cornish, Sudhalter, & Turk, 2004; Finestack et al., 2009; Mazzocco, Pennington, & Hagerman, 1994).

In addition to these physical and behavioral characteristics, communication and language are also impaired in FXS. Communication refers to the process of conveying meaningful information from one individual to another, via gestures and vocalizations, whereas language refers to a specific form of communication that relies on symbols (e.g., words) associated with specific meanings.

### **Communication and Language in FXS**

**Prelinguistic communication.** Prior to talking, children communicate with others in their environment by using gestures and vocalizations. Children with FXS tend to remain in this prelinguistic stage of language development longer than their typically developing peers (Abbeduto et al., 2007; Finestack et al., 2009). When they do begin to speak, their speech is often characterized by persistent articulation difficulties, a rapid and shifting speaking rate, and low intelligibility (Abbeduto & Hagerman, 1997; Belser & Sudhalter, 2001; Kover & Abbeduto, 2010), which can make conversing difficult. However, Abbeduto and Murphy (2004) found that adolescent and young adult males with FXS did not differ from typically developing mental age-matched children on a measure of intelligibility, and they concluded that intelligibility is on par with mental age expectations by adulthood.

**Receptive language.** Receptive language refers to the ability to understand spoken words and the way those words are used to convey an idea. For males with FXS, receptive language skills are typically below chronological age expectations (Abbeduto & Hagerman, 1997; Roberts, Mirrett, & Burchinal, 2001). Receptive language skills are also delayed relative to mental age expectations during childhood (Price, Roberts, Vandergrift, & Martin, 2007), but

increase over time (Roberts et al., 2001), and are typically commensurate with mental age by adolescence and adulthood (Abbeduto & Murphy, 2004; Abbeduto et al., 2003; Finestack et al., 2009). In contrast to males, females with FXS tend to have intact receptive vocabulary skills (Mazzocco et al., 2006). Results are mixed with regard to the influence of comorbid autism on receptive language skills. Philofsky, Hepburn, Hayes, Hagerman, and Rogers (2004) and Lewis et al. (2006) found that boys with FXS but not autism performed better on measures of receptive language than boys with both FXS and autism, but Price et al. (2007) found no differences between the two groups.

**Expressive language.** Expressive language refers to the ability to use spoken words to communicate with others. Like receptive language skills, expressive language skills in individuals with FXS lag behind chronological age expectations (Roberts, Hennon, et al., 2007). However, expressive language abilities are more impaired than receptive language skills in this population (Philofsky et al., 2004; Roberts et al., 2001). Roberts, Hennon, et al. (2007) and Sudhalter, Scarborough, and Cohen (1991) examined syntactic skills in boys with FXS and found that they were equivalent to the skills of younger typically developing boys. However, Price et al. (2008) found that the syntactic abilities of boys with FXS were lower than would be expected based on their nonverbal mental ages. Autism status does not differentially influence expressive language abilities (Lewis et al., 2006; Price et al., 2008). While many studies, including those just described, have examined broad measures of expressive language, research is lacking with regard to the use of specific vocabulary and morphosyntax by individuals with FXS, and still less is known about the developmental sequence of vocabulary acquisition in children with FXS.

**Pragmatics.** Within expressive language, pragmatics is an area of particular delay in individuals with FXS (Abbeduto et al., 2007; Abbeduto & Hagerman, 1997; Finestack et al., 2009). Pragmatics refers to the ability to follow cultural rules and expectations about how to communicate in different settings, as well as the ability to use contextual information to infer meaning during communication. In social interactions, individuals with FXS exhibit a unique pattern of language characteristics. A well-documented impairment is the high rate of verbal perseveration in the speech of males and females with FXS. Most perseveration takes the form of self-repetition (Ferrier, Bashir, Meryash, Johnston, & Wolff, 1991; Murphy & Abbeduto, 2007), as opposed to the echolalia frequently found in the speech of individuals with autism (Sudhalter & Belser, 2001; Sudhalter, Cohen, Silverman, & Wolf-Schein, 1990). Males with FXS are more likely to use self-repetitions than are ability-matched individuals with autism, Down syndrome, or nonspecific intellectual disability (Belser & Sudhalter, 2001; Roberts, Martin, et al., 2007; Sudhalter et al., 1990). In a more detailed investigation of repetitive language, Murphy and Abbeduto (2007) found that both males and females engaged in self-repetition of utterances and topics, but males produced more self-repetition of conversational devices than females. Mazzocco et al. (2006) also found that girls with FXS were more likely to use phrasal repetition than their typically developing female peers. As with general expressive language abilities, autism status does not differentially impact production of perseveration in boys with FXS (Roberts, Martin, et al., 2007).

Maintaining coherence within a conversation is another pragmatic skill that can be difficult for individuals with FXS. Both Sudhalter and Belser (2001) and Roberts, Martin, et al. (2007) found that males with FXS were more likely to produce utterances that were off-topic or tangential than were males with Down syndrome, autism, or typical development. Roberts,

Martin, et al. also found that boys with FXS and autism were even more likely to produce off-topic utterances than boys with FXS only. Females with FXS also have trouble with maintaining the coherence of a conversation. For example, Mazzocco et al. (2006) found that girls with FXS were less likely than their age-matched typically developing peers to ask questions that continued the conversation. In another study of discourse, Simon, Keenan, Pennington, Taylor, and Hagerman (2001) found that women with FXS but not intellectual disability had difficulty choosing appropriate endings to jokes relative to women without FXS. These studies suggest that while males with FXS have trouble with engaging in coherent conversation in general, females with FXS may have trouble with more subtle aspects of maintaining conversation coherence.

**Theory of Mind.** Another important aspect of pragmatics is the ability to understand what might be driving another person's behavior during social interactions. Theory of Mind (ToM) refers to the broad range of mental activities related to conceptualizing, understanding, and rationalizing other humans' behavior (Abbeduto & Murphy, 2004; Baron-Cohen, 1995; Lewis et al., 2006). At the most basic level, ToM is the ability to adopt another's perspective in order to predict or explain that other person's behavior (Grant, Apperly, & Oliver, 2007). More specifically, ToM is a strategy used to explain both typical behavior and behavior that violates expectations, and these skills are a vital aspect of successful social interactions. ToM abilities develop gradually during childhood, beginning with an understanding of intentionality during the first year of life and culminating in a beginning understanding of multiple-order beliefs (e.g., "Roger knows that Sarah guessed the right answer") and referential opacity that is typically in place by about five years of age (Baron-Cohen, 1995; de Villiers, 2007). Individuals with autism

usually show impairments in ToM (Baron-Cohen, 1995; Tager-Flusberg, 2000), as do individuals with FXS (Abbeduto & Murphy, 2004).

In conversations, adolescents with FXS tend to use ambiguous or inconsistent references, which suggests that they have trouble considering the informational needs of their conversation partner (Abbeduto & Murphy, 2004; Abbeduto et al., 2006). Both males and females with FXS have trouble indicating when they need clarification of an utterance during an interaction (Abbeduto et al., 2008), which can lead to misunderstandings or confusion. On tasks measuring perspective-taking, males with FXS have been found to perform both below mental age expectations (Garner, Callias, & Turk, 1999) and on par with mental age expectations (Abbeduto & Murphy, 2004). Findings are also mixed with regard to the performance of males with FXS relative to males with Down syndrome (DS) or nonspecific intellectual disability. Cornish et al. (2004) found that males with FXS performed as well as males with DS on a false-belief test, while Grant et al. (2007) found that males with FXS, regardless of autism status, performed worse than males with unspecified intellectual disability on several perspective-taking tasks. Abbeduto and Murphy (2004) found that adolescent and young adult males with FXS performed better on a false-belief task than did adolescent and adult males with DS. Garner et al. (1999) initially found a difference in performance between males with FXS and males with DS on a false-belief task, but this difference could be accounted for by overall ability level. Finally, while males with FXS have better rates of performance on perspective-taking tasks than males with autism (Cornish et al., 2004), autism status within FXS may negatively affect performance on these tasks (Grant et al., 2007). However, more studies comparing the performance of individuals with autism, FXS, and autism and FXS are needed before definitive conclusions can be drawn about the differences in ToM abilities in these populations.

## Mental State Verbs

Mental state verbs, such as *think*, *know*, *mean*, *like*, and *want*, are an integral part of ToM abilities. These verbs are the means by which individuals describe their own and others' representations of the world, and they allow individuals to make known their beliefs, desires, knowledge, and feelings about any situation. Since mental state verbs can refer to one's own mental processes and the mental processes of others (Symons, 2004), they allow people to successfully converse and interact with one another. Mental state verbs convey the speaker's point of view (Furrow, Moore, Davidge, & Chiasson, 1992; Harris, de Rosnay, & Pons, 2005; Howard, Mayeux, & Naigles, 2008) and contribute to the coherence of the conversation (Spanoudis, Natsopoulos, & Panayiotou, 2007). They also allow conversation partners to discuss past and future events (Beeghly, Bretherton, & Mervis, 1986). Finally, understanding mental state verbs is associated with the development of self-awareness and awareness of others (Booth, Hall, Robison, & Kim, 1997; Spanoudis et al., 2007; Symons, 2004).

Because of this role of mental state terms in interpersonal interactions, most researchers agree that the ability to use and understand mental state verbs is a vital part of social interaction (Baron-Cohen, 1995; Beeghly et al., 1986; Beeghly & Cicchetti, 1997; Bretherton & Beeghly, 1982; Brown, Donelan-McCall, & Dunn, 1996; Grant et al., 2007; Harris et al., 2005; Hughes & Dunn, 1997, 1998; Hughes, Lecce, & Wilson, 2007; Shatz, Wellman, & Silber, 1983; Symons, 2004; Tager-Flusberg, 1992). Conversational partners can use mental state verbs to provide each other with the right amount of information because each partner can express to the other what he or she knows or believes about a situation. Mastery of mental state verbs allows individuals to better understand the intentions behind certain behavior, including clarifying misunderstandings

during interactions (Baron-Cohen, 1995; Beeghly et al., 1986; Jenkins, Turrell, Kogushi, Lollis, & Ross, 2003).

Mental state verbs can be categorized in a variety of ways. Depending on the definition chosen, mental verbs may be classified as terms of volition/desire, cognition, or emotion/affect (Hall, Scholnick, & Hughes, 1987; Jenkins et al., 2003; Symons, 2004; Tager-Flusberg, 1992). The category of volition/desire typically includes the verbs *want*, *need*, or *hope*, while emotion/affect includes *like* and *love*. Cognition often includes verbs like *think*, *know*, *remember*, and *understand*. Mental state verbs are often considered a subset of internal state verbs, but not all internal state verbs are mental state verbs (e.g. verbs of perception and physiology).

Mental state verbs can also be categorized according to their contextual or conversational use. They can refer to true mental states (“She knew he was there”), modulate an assertion (“I think he went that way”), direct the interaction (“I guess I’ll be the mom”), clarify an utterance (“It’s blue, I mean red”), express desire (“I hope they have chocolate”), or describe the omission of an action (“Don’t forget my dolly”) (Shatz et al., 1983). Mental state verbs also can contrast between appearance and reality (“I thought those were socks, but really they were gloves”) (Bartsch & Wellman, 1995). Additionally, according to Booth et al. (1997), mental state verbs can be used in indirect requests (“Do you know what time it is?”) or in rhetorical questions (“Do you know how silly you are?”). Finally, mental state verbs can be part of conversational or filler phrases like *guess/know what?*, *I don’t know*, and *you know*. Hall et al. (1987) describe five levels of complexity in uses of mental state verbs: recognition (“I’ve seen this before”), recall (“Do you remember her name?”), understanding (“I know why you did that”), metacognition (“Use your imagination”), and evaluation (“I didn’t guess because I know the answer).

## **Mental State Verb Use in Typical Development**

Children first begin to use mental state verbs in spontaneous speech between 20 and 30 months of age (Beeghly & Cicchetti, 1997; Bretherton & Beeghly, 1982; Johnston, Miller, & Tallal, 2001; Shatz et al., 1983; Tager-Flusberg, 1992). Generally, *know*, *think*, and *want* tend to be used more frequently than other mental state verbs, though there are individual differences among children (Booth et al., 1997; Bretherton & Beeghly, 1982; Brown et al., 1996; Furrow et al., 1992; Hughes et al., 2007; Lee & Rescorla, 2008; Moore, Furrow, Chiasson, & Patriquin, 1994; Shatz et al., 1983). Even young children use mental state verbs for a variety of functions, including both reference to true mental states and conversational uses (Brown et al., 1996; Hughes & Dunn, 1998; Shatz et al., 1983), though the most common function is directing an interaction (Furrow et al., 1992; Shatz et al., 1983). Full mastery of mental state verbs involving certainty, like *know*, *think*, and *guess*, does not occur until the end of middle childhood (Howard et al., 2008; Naigles, 2000). Additionally, the multiple meanings of many mental state terms may contribute to the later development of this category of vocabulary (Booth et al., 1997; Frank & Hall, 1991; Hall et al., 1987; Howard et al., 2008; Naigles, 2000). Girls often use more mental state terms, and a greater variety of terms, than boys (Hughes & Dunn, 1998). Several studies have shown that children's use of mental state verbs is related to measures of general language development, including measures of receptive vocabulary, number of different words, and mean length of utterance (Bartsch & Wellman, 1995; Booth et al., 1997; Bretherton & Beeghly, 1982; Brown et al., 1996; Hughes & Dunn, 1997; Hughes, Fujisawa, Ensor, Lecce, & Marfleet, 2006; Jenkins et al., 2003).

## **Mental State Verb Use in Atypical Development**

While mental state verb use in typically developing populations has been well-documented, the literature is sparse for children with intellectual or developmental disabilities. Very few studies have examined the productive use of mental state verbs in these populations.

**Expressive language delay.** While typically developing children acquire and use mental state verbs in their first few years of life, children with atypical development may not use mental state verbs as much or as early in life. In two studies examining the spontaneous use of psychological state words in young children with expressive language delay, Lee and Rescorla (2002, 2008) found that at ages 3, 4, and 5, children with expressive language delay used fewer cognitive state terms than did their age- and MLU-matched counterparts. Interestingly, Lee and Rescorla (2008) found that the number of cognitive state terms used by 5-year-old children with expressive language delay was comparable to the number used by the typically developing (TD) 3-year-olds. In terms of language development, use of cognitive state terms was significantly correlated with both MLU and total number of words uttered at all three ages. Johnston et al. (2001) also examined spontaneous use of mental state term use in children with specific language impairment (SLI). They compared children with SLI with language-matched and mental age-matched TD children and found that children with SLI used significantly fewer cognitive state terms than the mental age-matched TD children and about the same amount of cognitive state terms as the language-matched TD children. According to these three studies, children who have typical mental development but atypical language development use fewer cognitive state terms than children who are developing typically.

**Down syndrome.** If mental state term use is reduced in children with language difficulties and typical mental abilities, it is highly likely that children with atypical language

development due to developmental disabilities will use fewer mental state terms as well. Both Hesketh and Chapman (1998) and Grela (2002) conducted studies of lexical verb use in children with Down syndrome (DS) in which they examined the use of mental state verbs in particular. Both studies found that children with DS used mental state verbs in their spontaneous speech. Grela (2002) found that children with DS did not differ in their use of mental state verbs compared to younger MLU-matched typically developing children. However, Hesketh and Chapman (1998) found that children with DS used fewer mental state verbs than younger MLU-matched typically developing children.

In a study examining mental state terms in the spontaneous speech of children with and without DS, Beeghly and Cicchetti (1997) found that 2- to 4-year-old children with DS produced more affective state terms and fewer cognitive state terms than their mental-age-matched peers, even after considering their cognitive abilities. Additionally, the children with DS were less likely to talk about the mental states of other agents than were the TD children, though both groups talked about the mental states of a variety of agents. Finally, the researchers found that in both the TD and DS groups, expressive language was significantly positively correlated with the total number of internal state terms as well as with the number of different internal state terms used by the children. Based on this information, Beeghly and Cicchetti concluded that children with DS follow the same developmental trajectory as TD children with regard to internal state term use, though the children with DS likely will never use as many terms as their typically developing counterparts.

**Autism.** In the only study known to examine mental state verb use in autism, Tager-Flusberg (1992) compared the use of mental state terms by children with DS to that of children with autism. The two groups of children were matched on chronological age and MLU, but not

mental age. Tager-Flusberg found that while both groups of children used a variety of types of mental state verbs, the children with autism used significantly more desire terms (e.g. *care*, *want*, *wish*) than did the children with DS. However, the children with autism were less likely to use cognitive state terms than were the children with DS. Both groups of children were more likely to refer to their own mental state than that of others. Based on these results, Tager-Flusberg concluded that children with autism as well as children with DS do have some understanding of mental states in self and other, but that both groups lag behind their typically developing peers. The children with autism rarely referred to cognitive states, and Tager-Flusberg suggests that this lack of language to talk about the mind may hamper their narrative abilities and social understanding skills.

**Implications for fragile X syndrome.** Because of the high comorbidity of autism and FXS, children with FXS may show a pattern of mental state term use similar to that of the children with autism in Tager-Flusberg's (1992) study. It is possible that any impairment in mental state verb use is due to the presence of autistic behaviors, but it is equally possible that impairment in the use of mental state verbs is an aspect of pragmatic impairments in FXS as well as in autism. In addition, some characteristics specific to FXS may influence mental state term use. Since children with FXS have difficulty with pragmatic skills, it is likely that impairment in the use of mental state verbs would be present in this population. At the same time, however, individuals with FXS understand that different people have different perspectives on the world (Abbeduto et al., 2007), which would suggest that mental state verb use would be a relative strength in FXS.

### **Mothers' Use of Mental State Verbs**

Several studies have shown that many aspects of mothers' language influence the linguistic development of their children (e.g. Furrow, Nelson, & Benedict, 1979; Hoff & Naigles, 2002; Huttenlocher, Haight, Bryk, Seltzer, & Lyons, 1991). Mothers' use of mental state verbs may be one of these aspects. Specifically, mothers' use of mental state verbs may have a positive influence on their children's use of mental state verbs as well as on their children's understanding of the abstract concepts associated with these verbs (Jenkins et al., 2003). Additionally, mothers may adjust their use of mental state verbs to their children's current linguistic abilities in order to facilitate learning (Beeghly et al., 1986; Tingley, Gleason, & Hooshyar, 1994).

#### **Mothers of Typically Developing Children**

Beeghly et al. (1986) conducted a study in which they examined the relationship between mothers' and their children's spontaneous use of internal state terms when their children were 13 months, 20 months, and 28 months of age. As expected, mothers' use of cognitive state terms increased as the children grew older, but increases in the use of desire and volition terms did not reach significance. Mothers' total internal state terms and number of different internal state terms were significantly correlated with children's receptive and expressive vocabulary at 13 months, expressive vocabulary at 20 months, and expressive and receptive vocabulary at 28 months, as well as with children's number of different internal state terms at 28 months. No significant correlations were found for child gender or temperament.

Furrow et al. (1992) also examined the spontaneous use of mental state verbs in conversations of mothers and their two- and three-year-olds during typical daily activities. Like Beeghly et al. (1986), Furrow et al. (1992) found that mothers' use of mental state verbs

increased as the children got older. They found that mothers, like their children, used primarily *think* and *know*, and that they used all mental state verbs mostly to direct the interaction. Finally, Furrow et al. found that mothers' use of mental state verbs was significantly correlated with their children's use when the children were 2;0, and that mothers' use when their children were 2;0 predicted children's use at 3;0.

Four other studies examined mothers' use of mental state terms as parts of larger investigations. Ruffman, Slade, and Crowe (2002) also found that mothers' early use of mental state utterances were significantly correlated with their children's later use of mental state terms, even after partialling out the children's early use of mental state terms. Finally, Moore et al. (1994), Booth et al. (1997), and Jenkins et al. (2003) all found that mothers' use of cognitive verbs was significantly correlated with their children's use of cognitive verbs. The findings of these studies suggest that maternal input plays an important role in the development of children's use of mental state terms.

### **Mothers of Children with Down Syndrome**

While mental state verb use by mothers of typically developing children seems to be positively related to their children's use of those verbs, such may not be the case for mothers of atypically developing children. Unfortunately, to date no studies comparing mothers' and children's use of mental state terms in atypical populations have been conducted. However, studies have examined the relationship between mothers' use of mental state verbs and various child characteristics. In addition to their study of TD children, Beeghly et al. (1986) conducted a small-sample study examining the spontaneous use of internal state terms by mothers of children with DS and comparing their use to that of mothers of chronological age-matched, mental age-matched, and language-matched typically developing children. Beeghly et al. found that the

mothers of children with DS used significantly fewer internal state terms than did the mothers of the TD children, regardless of group. Specifically, mothers of children with DS were less likely to use cognitive state terms and also less likely to refer to the internal states of others than were the mothers of TD children. Based on the results from this small sample, Beeghly et al. suggested that children with DS may be at an environmental disadvantage when it comes to learning internal state terms.

In a somewhat larger sample of children with DS, Tingley et al. (1994) also found that mothers of children with DS used fewer internal state terms than did mothers of ability-matched TD children. They, too, found that mothers of children with DS tended to use fewer cognitive terms than mothers of TD children, but unlike the Beeghly et al. study, Tingley et al. found that mothers of TD children also used more affect terms than did mothers of children with DS. Additionally, they found that while the TD children's MLU was significantly related to the number of cognitive state terms used by their mothers, the same was not true for the DS group. Tingley et al. suggested that the fewer affective and cognitive state terms used by mothers of children with DS may hamper their children's affective and cognitive development.

### **Implications for Fragile X Syndrome**

While none of these studies have examined FXS in particular, the use of mental state verbs by mothers of children with FXS may show a similar pattern. Specifically, these mothers may modulate their language to maximize their children's linguistic learning as happens with TD children and children with DS. However, unique characteristics found in these mothers because they are carriers of the fragile X mutation may play a role in the amount and type of mental state terms they use with their children. Specifically, the higher levels of social anxiety and depression often exhibited by females with FXS (Freund, Reiss, & Abrams, 1993) and the

pragmatic difficulties often found in women with FXS (Simon et al., 2001) may mean that they use fewer mental state verbs than expected. Additionally, they may use mental state verbs as conversational fillers more often than to refer to true mental states. Since children with FXS already have difficulty with pragmatics, such a pattern of use of mental state verbs by their mothers may not be as helpful for learning the connection between a specific mental state verb and its corresponding mental state in self and in others.

### **Current Study**

The purpose of the current study was to examine the use of mental state verbs (MSVs) in the spontaneous speech of children with fragile X syndrome. Based on the literature described above, four outcomes were hypothesized. First, children with FXS will use a variety of mental state verbs in their spontaneous speech, and that the use of those verbs will be positively related to their language abilities as measured by both standardized and observed measures. Second, their use of mental state verbs will be positively related to their cognitive and functional abilities. Third, children with high levels of autistic behaviors will use fewer mental state verbs than children who exhibit fewer autistic behaviors. Fourth, mothers' use of mental state verbs will be significantly related to their children's use.

### **Method**

#### **Participants**

The data for this analysis is drawn from a longitudinal study of maternal responsiveness and language development in children with fragile X syndrome (Warren, Brady, Sterling, Fleming, & Marquis, 2010). Since FXS is a rare disorder, the participants in this study were recruited from across the United States and demographic characteristics were not controlled for in selecting participants. Despite this being a sample of convenience, there is some variability. For this

analysis, 52 children (42 male) between 75 and 104 months of age ( $M = 91.88$ ,  $SD = 7.87$ ) and their mothers participated. All children had a diagnosis of full-mutation fragile X syndrome. Forty-seven children were Caucasian, two were African American, two were Caucasian/African American, and one was African American/Pacific Islander. Eleven of the children had no siblings, 22 had one sibling, 12 had two siblings, 5 had three siblings, and 2 had four or more siblings. At the time of data collection, 38 mothers were married, 9 were divorced, 4 were single, and 1 was separated. The sample was biased toward upper-middle socioeconomic status: 17 families had an income above \$100,000; 7 were between \$80,000 and \$100,000; 12 had an income between \$50,000 and \$80,000; 8 were between \$30,000 and \$50,000, and 8 had an income below \$30,000. Mothers' level of completed education ranged from 9<sup>th</sup> grade to doctoral degree, with a median education level of four years of college.

### **Observed Language Measures**

The children and their mothers were videotaped while interacting in their homes for a total of 45 minutes. The 45 minutes was divided into 15 minutes of structured contexts and a 30-minute unstructured context. In three 5-minute structured contexts, the mother-child dyads read books, completed a craft, and made and ate a snack. During the unstructured 30 minutes, they engaged in everyday activities. The three 5-minute contexts and two 5-minute segments taken from the 30-minute context comprised the 25 minutes of mother-child interactions used in this analysis.

During the home visit, mothers also completed the Five Minute Speech Sample (FMSS) to assess expressed emotion (Magana et al., 1986). The FMSS is a 5-minute interview during which mothers talk about their child and their relationship with that child without any feedback from the interviewer. The entire five minutes was audio recorded. The FMSS measures the

mothers' warmth, criticism, and over-involvement toward her child, and it has been found to be significantly related to a variety of child factors, including psychological and behavioral difficulties, in both typically developing children and children with intellectual disabilities (Beck, Daley, Hastings, & Stevenson, 2004).

**Child coding.** Each 5-minute video clip was coded for communicative acts by the child using Noldus The Observer 8.0 XT (Grieco, Loijens, Zimmerman, & Spink, 2008). All types and forms of communicative acts were coded, though only verbalized communicative acts were used in this analysis. All non-imitative, non-reading verbal acts were summed across the 25 minutes coded. During coding, every utterance by the child was transcribed. After being manually checked for errors, the child transcripts were analyzed using Systematic Analysis of Language Transcripts (SALT; Miller & Chapman, 1991). Both mean length of utterance (MLU) in morphemes and the number of different words (NDW) were calculated based on all intelligible utterances in the 25 minutes coded. The mean MLU was 1.89 (SD = 0.91) and the mean NDW was 148.69 (SD = 83.91). The transcripts then were examined by hand for instances of *you know*, *like*, and *I mean* that were used as conversational fillers, as well as uses of *I don't know* without a predicate complement. Instances of *like* and *feel* used in non-mental contexts (e.g. "push it like that?" and "feel this!") were also identified. Once these were removed, the transcripts were searched for mental state verbs, again using SALT software. Twenty-five different mental state verbs and their tense variations were examined. Alternate spellings and misspelled versions were included in the search. All 25 verbs have been shown to be present in the lexicon of typically developing children (Bartsch & Wellman, 1995; Brown et al., 1996; Hughes & Dunn, 1998; Shatz et al., 1983; Wellman, Phillips, & Rodriguez, 2000). Table 1 contains a list of the verbs and their spelling variations.

**Maternal Coding.** The mothers' FMSSs were transcribed by a neutral party and then analyzed using ATLAS.ti 5.0 (Muhr & Friese, 2004). ATLAS.ti is a qualitative data analysis program that allows for easy coding of selected terms in any type of media. It was chosen since the maternal interviews were not transcribed in a form readable by SALT. Mothers' transcripts were examined for instances of the same mental state verbs as the child transcripts, again excluding instances of *you know*, *like*, and *I mean* that were used as conversational fillers as well as non-mental uses of *like* and *feel*. The mean total number of mental state verbs used by the mothers in the FMSS was 18.76 (SD = 7.78, range 9 – 36). The mean number of different mental state verbs used by the mother was 6.31 (SD = 1.87, range 2 – 10). The mothers' number of different mental state verbs used was utilized in all analyses.

### **Standardized Measures**

Each standardized measure is briefly described below and summarized in Table 2.

**Vocabulary.** To assess receptive and expressive vocabulary, children were given the Peabody Picture Vocabulary Test – 4<sup>th</sup> Edition (PPVT-4; Dunn & Dunn, 2007) and the Expressive Vocabulary Test – 2<sup>nd</sup> Edition (EVT-2; Williams, 2007) during the home visit. In the PPVT-4, children are asked to point to the picture that matches the word spoken by the experimenter. The resulting score gives an indication of the individual's receptive language abilities. The mean PPVT-4 raw score for this sample was 67.94 (SD = 34.96). In the EVT-2, children are asked to verbally respond to a question about the presented picture. The resulting score gives an indication of the individual's expressive language abilities. In this sample, the mean EVT-2 raw score was 46.13 (SD = 28.51). Because of floor effects on both tests, raw scores, rather than standard scores, were used in all analyses.

**Nonverbal IQ.** To assess nonverbal IQ, the children were given four subscales of the Visualization and Reasoning Battery of the Leiter Interational Performance Scale – Revised (Leiter-R; Roid & Miller, 1997). The four subscales – Figure Ground, Form Completion, Sequential Order, and Repeated Patterns – comprise the Brief IQ measure. The four subscales are given without verbal instruction or feedback from the researcher, and together they are intended to give an indication of an individual’s cognitive ability regardless of language ability. Testing was attempted with all 52 children, but only 45 completed all four subscales. The seven children who did not complete testing did not achieve basal on all four subscales. For those 45 children who completed the Leiter-R subscales, the mean nonverbal IQ was 56.16 (SD = 15.31).

**Autistic Behaviors.** After the home visit, the two researchers completed the Childhood Autism Rating Scale (CARS; Schopler, Reicher, & Renner, 1988) independently and then compared responses. Any discrepancies were resolved through discussion. The CARS is a 15-item rating scale that measures the presence and degree of autistic behaviors. Scores can range from 15 to 60, with a score of 30 or above considered consistent with a diagnosis of autism and scores of 36 and above indicating the presence of severe autistic behaviors. The CARS can be used as an autism screener, but for this study it was used to examine the degree of autistic behaviors. The mean CARS score for the 52 children examined was 26.14 (SD = 7.02).

**Adaptive Behaviors.** During the home visit, mothers completed the Vineland Adaptive Behavior Scales (VABS; Sparrow, Balla, & Cicchetti, 1984) for their children. The VABS measures an individual’s everyday functioning abilities in four subdomains: communication, daily living skills, socialization, and motor skills. The Adaptive Behavior Composite (ABC) gives an overall measure of daily functioning. For this sample, the mean ABC was 53.51 (SD = 17.52).

## Results

Pearson product-moment correlations were conducted to examine the relationship between mental state verb use and various child characteristics. Four separate regression models were then built to examine three different child characteristics and maternal mental state verb use as predictors of children's production of mental state verbs. Results are grouped below according to the independent variable examined.

### Mental State Verb Use

Children with FXS used a variety of mental state verbs in their spontaneous speech with their mothers. The children used a mean of 15.12 mental state verbs ( $SD = 15.35$ ) and a mean of 4.19 ( $SD = 2.86$ ) different mental state verbs in 25 minutes of spontaneous speech. Following Hall et al. (1987), differences in tense or spelling across words with the same stem were considered the same word. For example, instances of *loving* and *loves* both qualify as a use of *love*. Interestingly, the most frequently used mental state verbs were *want*, *need*, *like*, and *know*. Because of the wide variability in the total number of mental state verbs used (range: 0 – 83), the number of different mental state verbs used (range: 0 – 11) was utilized as the dependent variable in subsequent analyses. Additionally, a one-way ANOVA showed no differences in the number of different mental state verbs used by the girls and boys,  $F(1,50) = 1.250$ ,  $p = 0.269$ , so the entire sample was used in subsequent analyses.

### MSVs and Language Abilities

Four measures of language ability were significantly related to the children's MSV use. As can be seen in Table 3, the number of different mental state verbs used was significantly correlated with raw scores on two standardized measures of language ability: the PPVT-4,  $r = 0.752$ ,  $p < .001$ ; and the EVT-2,  $r = 0.737$ ,  $p < .001$ . Additionally, two observed measures of

language ability were significantly correlated with the number of different mental state verbs used: MLU in morphemes,  $r = .720, p < .001$ ; and NDW,  $r = 0.837, p < .001$ .

To determine whether or not raw scores on the EVT-2 significantly predicted the number of different mental state verbs used, a regression model was built. The EVT-2, rather than MLU or NDW, was chosen to represent expressive vocabulary because scores on the EVT-2 are not based on the transcripts from which the MSVs were drawn. Nonverbal IQ was entered first in the model to control for differences in cognitive abilities, and then raw scores on the EVT-2 were entered. As can be seen in Table 4, raw scores on the EVT-2 significantly predicted the number of different mental state verbs used even after controlling for nonverbal IQ.

### **MSVs and Developmental Level**

Although chronological age was not significantly related to mental state verb use,  $r = -0.034, p = 0.812$ , developmental level and mental state verb use were correlated. Nonverbal IQ from the Leiter-R was significantly correlated with mental state verb use,  $r = 0.543, p < .001$ , as was the Adaptive Behavior Composite from the VABS,  $r = 0.653, p < .001$ . A regression model was built to examine the predictive value of daily functioning abilities on the number of different mental state verbs used. Nonverbal IQ was entered first to control for general cognitive abilities, and then the ABC was entered. As shown in Table 5, daily functioning skills, as measured by the Vineland ABC, significantly predicted the number of different mental state verbs used, even after controlling for nonverbal IQ.

### **MSVs and Autistic Behaviors**

Scores on the CARS were significantly negatively correlated with the number of different mental state verbs used by the children,  $r = -.576, p < .001$ . To examine whether autistic behaviors predicted the number of different mental state verbs used, a regression model was built

in which raw scores on the EVT-2 were entered first to control for expressive language ability. Then, scores on the CARS were entered to determine how much variance in the number of different MSVs used was accounted for by the presence and degree of autistic behaviors. Unexpectedly, as shown in Table 6, autistic behaviors did not significantly predict the number of different MSVs after controlling for language ability.

### **MSVs and Maternal Use of MSVs**

The number of different mental state verbs used by mothers was not significantly related to their children's use. The two variables were not significantly correlated,  $r = -.113$ ,  $p = .431$ , and as can be seen in Table 7, mothers' use of MSVs did not significantly predict children's use.

### **Discussion**

This study is one of the first to investigate a specific aspect of vocabulary used by children with fragile X syndrome. In this analysis, the use of mental state verbs in spontaneous conversations by children with FXS was examined. As expected, children with FXS did use several mental state verbs in conversations with their mothers, and many of them used a variety of different MSVs in 25 minutes. The use of mental state verbs was significantly related to several measures, both standardized and observed, of children's receptive and expressive language abilities, which is consistent with published research. Scores on a standardized measure of expressive vocabulary, the EVT-2, were significantly predictive of the use of mental state terms even after controlling for nonverbal IQ. This suggests that for children with FXS, cognitive ability alone does not account for differences in the use of mental state verbs. In other words, even after accounting for cognitive ability, expressive vocabulary still influences the use of mental state verbs for these children.

Though in many studies of typically developing children the most frequently used mental state verbs were *know*, *think*, and *want*, that was not the case in this study. For this sample, children with FXS used *want*, *need*, and *like* more often than *know*. However, the contexts from which the children's speech was collected may have been more conducive to using *want*, *need*, and *like*. More specifically, the craft-making context may have contributed to the high frequency of use of *need* because the children often had to request specific craft parts from their mothers. Additionally, the book-reading and snack-making contexts may have influenced the frequent uses of *want* and *like* because the children were often asked to indicate their preferences about what book to read and what snack to eat.

Chronological age was not significantly related to mental state verb use in this sample of children with FXS. However, two measures of developmental ability, nonverbal IQ and adaptive behavior, were significantly related to the use of MSVs by these children. Adaptive behavior in children with FXS significantly predicted mental state verb use, even after controlling for nonverbal IQ. In other words, everyday living skills significantly predicted the use of mental state verbs even after controlling for the effects of cognitive abilities.

Though autistic behaviors were negatively correlated with MSV use, the presence and degree of autistic behaviors in children with FXS was not significantly predictive of mental state verb use after controlling for language ability. This suggests that, contrary to expectation, the use of mental state verbs is tied to language ability and not autism in these children. In other words, children with lower expressive language abilities, rather than children with more autistic behaviors, tend to use fewer mental state verbs in conversations with their mothers. This finding suggests that the pragmatic impairments in FXS influence the use of mental state verbs regardless of the presence of autistic behaviors. It may be that the specific aspects of pragmatics

that are problematic in FXS, rather than the pragmatic difficulties found in autism, relate to the use of mental state verbs. Impairments in specific pragmatic abilities such as perseveration and conversational coherence may be found in children with FXS independent of the presence of autistic behaviors and thus may have a stronger influence on the use of mental state verbs in this population. Future studies should examine this relationship more carefully by including converging measures of autistic behaviors and more specific uses of mental state verbs, and by investigating the use of mental state verbs and a variety of pragmatic skills in individuals with autism, FXS, and both autism and FXS.

Another unexpected finding was that mothers' use of mental state verbs was not significantly related to their children's use. At first glance, this seems to suggest that for children with FXS, environmental input does not play a large role in their use of mental state verbs. However, there are a few possible reasons why the current analysis did not replicate past studies. First and foremost, the length and contexts of the transcripts for mothers and their children differed drastically. In the FMSS, mothers were speaking to another adult and not directly to their children. Because of this, mothers may not have modulated their language to match their children's abilities since their children were not present in the interview. This fact suggests that the mere use of mental state verbs by mothers of children with FXS is not beneficial to their children's linguistic development. It may be that mothers' use of these verbs must be directed toward their children for there to be a linguistic benefit for the children. Future studies examining samples of mothers' speech from conversations with their children would address this issue.

In sum, the present study provides evidence that children with fragile X syndrome do use a variety of mental state verbs in conversations with their mothers, and that the use of these verbs

is related to the children's language and developmental abilities, but not to their autistic behaviors or their mothers' use of mental state verbs. The findings suggest that pragmatic and social communication impairments in FXS may not be heavily influenced by autistic behaviors.

### **Limitations**

As with any research, some limitations of the current study must be addressed. The 25 minutes of utterances by children with FXS was not drawn from a continuous conversation with their mothers but rather from five separate five-minute structured and unstructured interactions. Additionally, mothers' utterances were drawn from an entirely different five-minute context. Examining the mental state verbs in a set of utterances drawn from a continuous conversation between a mother and her child may give a better indication of the relationship between mothers' and children's use of mental state verbs.

A second limitation of this analysis is that the sample was one of convenience. Gender, age, developmental level, and language abilities varied widely among the 52 children, and no information about mothers' IQ, language abilities, or socioeconomic status was included. Matching the children with FXS on age, gender, developmental level, or language ability may help illuminate the sources of differences in use of mental state verbs. In addition, maternal characteristics such as MLU, pragmatic abilities, or education level may play a role in their children's use of mental state verbs.

### **Future Directions**

Future studies should focus on determining the nature of mental state verb use in children with FXS. A natural next step in examining the use of mental state verbs in children with FXS would be to include comparison groups of children with autism and typically developing children who are matched on age and language abilities to the children with FXS. Additionally,

an analysis of the variety of conversational uses of mental state verbs by children with FXS would add to knowledge of their pragmatic abilities, as would a comparison of their use of mental state verbs and performance on tasks examining ToM abilities. Finally, collecting samples of mental state verb use from the same children at several time points would help determine if the acquisition and use of mental state verbs in children with fragile X syndrome is similar to that of typically developing children.

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**Table 1. Mental State Verbs Examined**

<u>Mental State Verbs</u>	<u>Other Tenses &amp; Spellings</u>
like	likes, liked, liking
dislike	dislikes, disliked, disliking
want	wanna, wants, wanted, wanting
feel	feels, felt, feeling, feeled
love	loves, loved, loving
hate	hates, hated, hating
hope	hopes, hoped, hoping
wish	wishes, wished, wishing
need	needs, needed
know	knows, knew, knowing, knowed
think	thinks, thought, thinking, thinked
pretend	pretends, pretended, pretending
remember	remembers, remembered, remembering
forget	forgets, forgot, forgetting, forgeted, forgetted
wonder	wonders, wondered, wondering
confuse	confuses, confused, confusing
doubt	doubts, doubted, doubting
imagine	imagines, imagined, imagining
dream	dreams, dreamt, dreamed, dreaming
guess	guesses, guessed, guessing
desire	desires, desired, desiring
mean	means, meant, meaning, meanted
figure	figures, figured, figuring
bet	bets, betting, betted, beted
believe	believes, believed, believing

**Table 2. Standardized Measures**

	<i>N</i>	<i>Mean (SD)</i>	<i>Range</i>
PPVT-4 raw score	52	67.94 (34.96)	3 – 127
EVT-2 raw score	52	46.13 (28.51)	0 – 98
Leiter-R Brief IQ	45	56.16 (15.31)	36 – 102
CARS total score	52	26.14 (7.02)	16 – 44.50
VABS Adaptive Behavior Composite	49	53.51 (17.52)	31 – 108

**Table 3. Correlations between Language Measures and the Number of Different Mental State Verbs used**

	PPVT-4 raw score	EVT-2 raw score	MLU in morphemes	Number of Different Words	# of different Mental State Verbs
PPVT-4 raw score	1				
EVT-2 raw score	.855**	1			
MLU in morphemes	.749**	.719**	1		
Number of Different Words	.766**	.824**	.817**	1	
# of different Mental State Verbs	.752**	.737**	.720**	.837**	1

\*\* . Correlation is significant at the .001 level (2-tailed).

**Table 4. Summary of Regression Model Predicting the Number of Different Mental State Verbs Used by IQ and Expressive Language Ability**

Variables	$R^2$ change	$F$ change ( $df$ )	$p$	$\beta$
Nonverbal IQ (Leiter-R standard score)	.295	17.961 (1, 43)	< .001	.181
EVT-2 raw score	.205	17.176 (1, 42)	< .001	.579

**Table 5. Summary of Regression Model Predicting the Number of Different Mental State Verbs Used by Daily Functioning Abilities**

Variables	<i>R</i> <sup>2</sup> change	<i>F</i> change ( <i>df</i> )	<i>p</i>	<i>β</i>
Nonverbal IQ (Leiter-R standard score)	.267	14.949 (1, 41)	< .001	.208
Vineland Adaptive Behavior Composite (ABC)	.108	6.888 (1, 40)	0.012	.451

**Table 6. Summary of Regression Model Predicting the Number of Different Mental State Verbs Used by Autistic Behaviors**

Variables	$R^2$ change	$F$ change ( $df$ )	$p$	$\beta$
EVT-2 raw score	.543	59.485 (1, 50)	< .001	.608
CARS score	.032	3.671 (1, 49)	0.061	-.220

**Table 7. Summary of Regression Model Predicting the Number of Different Mental State Verbs Used by Moms' Number of Different Mental State Verbs Used**

Variables	$R^2$ change	$F$ change (df)	$p$	$\beta$
EVT-2 raw score	.573	65.740 (1, 49)	< .001	.754
Maternal # of different mental state verbs used	.001	0.079 (1, 48)	0.781	-.027