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Humor Perception: The Contribution of Cognitive Factors

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HUMOR PERCEPTION: THE CONTRIBUTION OF COGNITIVE FACTORS

by

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Under the Direction of Mary Morris

ABSTRACT

Most of the extant humor research has focused on humor comprehension with only a few studies investigating humor appreciation as a separate construct. The purpose of this investigation was to determine the relation between humor and underlying cognitive processes. Literature on brain injured individuals has indicated that working memory, verbal and visual-spatial reasoning, cognitive flexibility, and concept formation are related to performance on comprehension tests of humor. In this study, cognitive processes underlying both verbal and nonverbal humor were investigated in a sample of healthy young adults. There is evidence that semantic and phonological humor are associated with different neural networks; therefore, both semantic and phonological humor were explored. Studies investigating physiological arousal and humor have indicated that arousal is necessary for the experience of humor. This suggests that the appreciation of humor may require the integration of cognitive and affective information, a process mediated by the ventromedial prefrontal cortex (VMPFC). Thus, a second goal of this study was to investigate the relationship between humor comprehension and appreciation and the VMPFC, by including experimental tasks that previously have been linked to VMPFC functioning. Participants included 94 undergraduate psychology students between the ages of 18 and 39 years. Participants watched film clips and listened

to jokes. After the presentation of each joke and each film clip, they completed a humor comprehension/appreciation inventory developed for this study. They also completed measures assessing a range of cognitive abilities hypothesized to underlie humor perception. Hierarchical regression analyses revealed that verbal reasoning was predictive of semantic humor comprehension, indicating that verbal reasoning is a core cognitive ability for the comprehension of jokes in which the humor depends on factors other than simple word play. Cognitive measures were not predictive of phonological humor comprehension or nonverbal humor comprehension. Hierarchical regression analyses revealed that the indicators of VMPFC functioning did not correlate with either humor comprehension or humor appreciation and did not moderate the relation between humor comprehension and humor appreciation. Future research is necessary to elucidate the relationships between cognitive abilities and humor perception and to further explore the contribution of the VMPFC to humor appreciation.

INDEX WORDS: Humor, Neuropsychology, Ventromedial Prefrontal Cortex

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LIST OF ABBREVIATIONS

AS	Asperger Syndrome
D-KEFS	Delis Kaplan Executive Function System
ERP	Event-Related Potential
fMRI	Functional Magnetic Resonance Imaging
HFA	High Functioning Autism
IGT	Iowa Gambling Task
NLD	Nonverbal Learning Disorder
NVH	Nonverbal Humor
PH	Phonological Humor
SH	Semantic Humor
TH	Total Humor
ToM	Theory of Mind
VH	Verbal Humor
VMPFC	Ventromedial Prefrontal Cortex
WAIS-3	Wechsler Adult Intelligence Scale – Third Edition
WJ-3	Woodcock Johnson – Third Edition
WMS-3	Wechsler Memory Scale – Third Edition

CHAPTER 1

LITERATURE REVIEW

Humor is a uniquely human trait that serves many functions in everyday life. Investigations of humor have demonstrated a clear relationship between humor appreciation and social functioning. The ability to appreciate humor facilitates social behavior and, therefore, has a vital role in social relationships. Humor is a social instrument that provides an effective way to reduce psychological distress, communicate a range of feelings and ideas, and enhance relationships. Brownell and Gardner (1988) assert that because humor provides a means of socialization that adds to one's enjoyment in life, any disruption of a person's ability to understand humor will have a negative effect on his/her overall quality of life.

Humor appreciation is associated with reduced loneliness, decreased anxiety and depression, and higher self-esteem, all of which can impact social relationships. People who frequently experience humor reported less mood disturbance to stressful life events than less humor-prone individuals (Keltner & Bonanno; 1997; Martin & Lefcourt, 1983). In an investigation of the relationship between humor and psychological health, Thorson, Powell, Sarmany-Schuller, and Hampes (1997) found that scores on a humor inventory were positively related to optimism and self-esteem and negatively related to psychological distress and depression. Overholser (1992) found that the use of humor as a coping mechanism was associated with higher self-esteem and reduced loneliness and depression in college students.

Humor provides a means to communicate ideas and feelings, convey criticism, and express hostility in a socially acceptable manner (Brownell & Gardner, 1988; Dixon, 1980; Haig, 1986; Martin, 2001). Daws, Kaplan, and Winner (1995) studied the social function of humor when conveying criticism. They found that humor served to soften criticism by making it less insulting than literal criticism. In addition, individuals who used humor when conveying criticism appeared less angry and more in control than those who spoke literally. The authors concluded that humor protects social relationships when communicating negative information.

In addition to assuaging negative affect and experiences, humor appreciation enhances positive aspects of life. In social interactions, a shared appreciation of humor serves to establish and maintain social bonds by creating and enhancing feelings of rapport (Haig, 1986; Mosak, 1987; Vinton, 1989). A sense of humor is associated with more positive and rewarding interpersonal encounters. In a comparison of the social relationships of individuals who frequently experienced humor and those who did not, the individuals who stated that they frequently experienced humor also reported having closer social relationships (Hampes, 1994). A shared humorous experience also has been found to create feelings of closeness in initial encounters between strangers (Fraley & Aron, 2004). Keltner and Bonanno (1997) investigated the role of humor appreciation in the social relations of bereaved participants. Those individuals who reported experiencing more humor in their interactions rated their social relationships as more pleasurable than those who did not. Krokoff (1991) established that coping with humor was beneficial for intimate relationships by demonstrating its relationship to enhanced marriage satisfaction

and reduced job distress among married couples. In an investigation of the social role of humor, Nezlek and Derks (2001) explored the relationships among social interaction, psychological adjustment, and humor using interaction records, humor inventories, and psychological inventories assessing self-esteem and social competence. They found that the use of humor was positively related to enjoyment and confidence in social interactions.

Humor is a highly valuable trait. Cann and Calhoun (2001) investigated the social desirability of humor. Participants rated a set of adjectives relating to individuals previously described as having varying senses of humor. Those individuals described as having excellent senses of humor were rated more highly on socially desirable adjectives than those described as having average or below average senses of humor. When college students were asked to indicate behaviors that they felt were effective in attracting the opposite sex, the most commonly mentioned characteristic was a strong sense of humor (Buss, 1988). In an investigation of nonverbal signs of interest in opposite-sex encounters, Grammer (1990) found that unacquainted males and females used humor as a primary strategy to convey interest in each other.

Complementing this body of research demonstrating the social benefits of humor are studies that link deficits in humor perception with impaired social functioning in clinical populations with both developmental and acquired neurological disorders. High functioning autism (HFA), Asperger syndrome (AS), and nonverbal learning disorder (NLD) are all characterized by social deficits, and there is significant overlap in the nature of these difficulties across these diagnostic categories. Studies investigating humor

in individuals with Asperger syndrome and autism have demonstrated that individuals with autism and Asperger syndrome are more likely to understand basic forms of humor that do not require inferences, such as slapstick humor and puns; however, their understanding of these and other types of humor (e.g. semantic jokes and nonverbal cartoons) is significantly poorer than typically developing individuals (Emerich, Creaghead, Grether, Murray, & Grasha, 2003; Reddy, Williams, & Vaughan, 2002; St. James & Tager-Flusberg, 1994; Van Bourgondien & Mesibov, 1987). Although there have been no prior empirical studies of humor in individuals diagnosed with NLD, clinical anecdote suggests that they also have problems with humor perception.

Impaired humor perception is a common characteristic of another group of individuals with impaired social perception, those with acquired right hemisphere brain damage. Studies of adults with unilateral lesions in the right hemisphere show that they perform more poorly than those with left hemisphere damage on tasks in which they have to interpret social cues, understand jokes and cartoons, understand metaphors, and use and understand pragmatic communication (Gillikin & Derks, 1991; Joanette, Goulet, & Hannequin, 1990; Molloy, Brownell et al., 1990; Moscovitch, 1983; Shammi & Stuss, 1999; Weylman, Brownell, & Gardner, 1988; Winner & Gardner, 1977).

Components of Humor

Humor is a multifaceted phenomenon for which several theories have been developed. Incongruity, the presence of at least two potential meanings that are incompatible with each other, is the structural feature that is considered the central characteristic of humor (Morreall, 1989; Raskin, 1985; Ruch, McGhee, & Hehl, 1990).

According to Rothbart (1973), the humor response derives from the mere presence of incongruity. Katz (1993) developed a connectionist model of humor, which states that the humor response is a function of the presence of a combination of incongruities and the personal relevance of the material. The most widely accepted theory of humor perception is the incongruity/resolution model (Suls, 1972). According to this model, incongruity between an expected outcome and a surprising actual outcome is a vital component of both verbal and physical humor (Fry, 2002; Morreall, 1989; Paulos, 1980; Raskin, 1985; Ruch, McGhee, & Hehl, 1990). For material to be found humorous there must be the identification of something unexpected, illogical, or inappropriate followed by the resolution (justification or reinterpretation) of that incongruity. Suls contends that the process of detection and reconciliation of the incongruity makes humor comprehension a problem-solving task. Fry (2002) supports that notion and argues that error detection and response competition are necessary for humor comprehension. He asserts that error detection occurs when one recognizes the incongruity, and response competition occurs when one resolves the incongruity and "gets" the joke.

Humor perception has been used synonymously with humor comprehension in the literature, and some investigators have used it to denote both humor comprehension and humor appreciation. Ziv (1984) drew a distinction between two aspects of humor. Humor comprehension has been described as the ability to perceive relationships or ideas in incongruous ways, whereas humor appreciation has been defined as the ability to understand and get pleasure from humorous messages (Ziv, 1984). Research has attempted to determine the cognitive and affective processes that underlie both the

comprehension and appreciation of humor. Some researchers have extrapolated the prerequisites for humor comprehension and appreciation from processes related to social perception. Others have investigated the relationship between particular cognitive processes and funniness ratings of stimuli and/or performance on tasks designed to assess humor comprehension. Another line of research has examined humor appreciation and fluctuations in physiological arousal in an attempt to uncover another contributor to humor appreciation.

Cognitive Processes Related to Humor

Studies of brain injured individuals have suggested that deficits in particular cognitive processes accompany impaired humor perception. In a study using a nonverbal cartoon completion task, Bihrl, Brownell, Powelson, and Gardner (1986) demonstrated that although patients with right hemisphere damage were sensitive to the surprise element of humor, they had a reduced ability to establish coherence, which requires the integration of content across a narrative. That study echoed conclusions that were drawn when Brownell, Michel, Powelson, and Gardner (1983) compared individuals with right hemisphere strokes to neurologically intact individuals. When selecting the punch line of a joke, the individuals with right hemisphere damage selectively chose endings that contained the element of surprise but were not coherent with the content of the joke. In addition, they chose more non sequitur endings than the control group. Dagge and Hartje (1985) investigated humor in individuals with right hemisphere brain damage using neutral and humorous cartoons of varying complexity (i.e. those in which the humor was based on perceptual incongruity and those in which the humor was based on behavioral

incongruity). The participants were asked to describe the details of each of the cartoons and identify the humorous cartoon from a multiple choice of four. The participants with right hemisphere damage had impaired ability to distinguish between neutral and humorous cartoons in both incongruity conditions, which appeared to be related to difficulties with visual-spatial skills as evidenced by their descriptions of the cartoons. In another study of adults with right hemisphere brain damage, Gillikin and Derks (1991) used uncaptioned cartoons and examined participants' feedback about the events in the cartoons and their funniness ratings. The participants rated neutral and humorous cartoons similarly, and their comments tended to be related to the expressions of the cartoon characters. Overall, their responses to the cartoons reflected focus on irrelevant detail, tangential thinking, and lack of integration of the details in the cartoons. The authors concluded that difficulty discriminating funny from unfunny visual stimuli was related to poor task integration and concept formation.

Humor perception may not be a unitary construct. Different types of humor may require different underlying cognitive abilities. Shammi and Stuss (1999) used joke and story completion tasks and a funny versus unfunny cartoon discrimination task in an investigation of humor comprehension in individuals with isolated regions of brain damage. They found that performance on a measure of working memory was positively related to both the verbal (jokes) and nonverbal (cartoon) comprehension tests of humor in patients with left frontal and right frontal brain damage. In addition, verbal humor was related to verbal abstraction ability and mental flexibility, whereas nonverbal humor was related to visual attention.

Research with developmental disorders suggests that Theory of Mind (ToM) also may contribute to humor perception. ToM is the ability to conceive of others' mental states (Baron-Cohen, Leslie, & Frith, 1985). It is possible that humor perception requires an understanding of others' intentions and emotional states (Shamay-Tsoory, Tomer, & Aharon-Peretz, 2005). The social deficits in high functioning autism and Asperger syndrome have been associated with impaired ToM abilities (Baron-Cohen et al., 1999), and there is a strong correlation between ToM abilities and the ability to explain non-literal messages such as jokes, irony, and sarcasm (Happe, 1993, 1994). To detect irony, inferences must be made about the speaker's knowledge and intensions (Dews & Winner, 1997; McDonald, 1999; Winner, 1998), suggesting that ToM is likely to be an underlying process of humor perception. Impairment in the pragmatic aspects of language, another characteristic of autism and Asperger syndrome (Tager-Flusberg, 1981), affects social communication and verbal humor perception (Happe, 1993, 1994; Minshew, Goldstein, & Siegel, 1995). There is general agreement that pragmatics and ToM are closely associated (Dunn, Brown, Slomkowski, Tesla, & Youngblade, 1991; Happe, 1995; Tager-Flusberg, 1997), providing further evidence that ToM abilities are important in humor perception. In contrast to some of the previously investigated cognitive correlates of humor, Theory of Mind is strongly linked to the processing of affective information and social functioning and therefore may be particularly relevant to an understanding of humor appreciation.

In summary, prior studies have identified several specific cognitive abilities as potential correlates of impaired humor perception. Working memory, verbal and visual-

spatial reasoning, cognitive flexibility, and concept formation all have been linked to performance on measures of humor in adults with acquired brain lesions. Studies of individuals with developmental disorders have linked humor perception to performance on measures that tap Theory of Mind capacity. However, the pattern of relationships may vary across different types of humor measures that utilize either verbal or nonverbal stimuli or that emphasize either comprehension of humorous material or humor appreciation.

Humor appreciation may not be a purely cognitive operation and may require the mobilization of additional affective processes. The cognitive element (humor comprehension) refers to understanding the humor ("getting the joke") by detecting the disparities between the humorous material and prior experiences; whereas the affective element (humor appreciation) refers to the experience of enjoyment (emotional response) of humorous material (Brownell, Michel, Powelson, & Gardner, 1983). Prior research has explored the potential role of affective processes in addition to cognitive processes in the appreciation of humor, and investigations of these affective processes have focused on fluctuations in physiological arousal. Upon hearing a funny joke, the body experiences increased heart rate and skin conductance response, and this arousal is followed by a strong, positive affective reaction (humor response) (Goldstein, Harman, McGhee, & Karasik, 1975; Katz, 1993; McGhee, 1983). Godkewitsch (1996) also demonstrated that funniness ratings of orally presented humorous riddles were positively related to heart rate and skin conductance responses. Changes in skin conductance differentiated humorous riddles from non-humorous questions although changes in heart rate did not,

suggesting that physiological arousal mediates the humor response. This conclusion reiterated that of Langevin and Day (1972) who found that heart rate and skin conductance responses increased as a function of the funniness ratings of captioned cartoons. In summary, prior studies raise the possibility that physiological arousal may be a critical component of the experience of humor, and that the appreciation of humor may require the integration of cognitive and affect information.

Neural Basis of Humor

Although the precise neural correlates of humor comprehension and appreciation remain unclear, there is evidence that the right hemisphere and the frontal lobes are involved. The role of the ventromedial prefrontal cortex (VMPFC) in humor has been less extensively studied; however, given its importance in social functioning and its hypothesized role in the integration of cognitive and affective information, this region may be particularly critical for humor appreciation.

The Right Hemisphere

Studies of individuals with developmental disorders, patients with acquired brain lesions, and neurologically healthy participants provide several converging lines of evidence that support the hypothesis that the right hemisphere is specialized for processing a variety of socioemotional stimuli including humorous material (Gainotti, 1972; Gardner, Ling, Flamm, & Silverman, 1975; Shammi & Stuss, 1999). Asperger syndrome and nonverbal learning disorder have been associated with cognitive impairments that implicate right hemisphere deficits such as difficulty interpreting nonverbal social cues and impaired visual-spatial-organizational abilities (Berthier,

Bayes, & Tolosa, 1993; Ellis, Ellis, Fraser, & Deb, 1994; Ellis & Gunter, 1999; Gunter, Ghaziuddin, & Ellis, 2002; Johnson & Myklebust, 1967; McKelvey, Lambert, Mottron & Shevell, 1995; Rourke & Finlayson, 1978; Rourke & Strang, 1978; Rourke & Telegdy, 1971; Volkmar et al., 1996), and, as previously noted, both groups demonstrate impaired humor perception. They also have difficulty integrating information to construct a global meaning (an ability attributed to the right hemisphere), which is necessary for getting the general idea of a joke (Frith, 1989; Happe, 1997; Jolliffe & Baron-Cohen, 2000). Studies have shown that patients with right hemisphere strokes perform worse than those with left hemisphere strokes on tasks of verbal and nonverbal humor appreciation and emotional responsiveness to humorous stimuli (Shammi & Stuss, 1999; Wapner, Hamby, & Gardner, 1981).

Studies of healthy adults also have found links between humor perception and indices of right hemisphere functioning. Johnson (1990) found a positive correlation between mental rotation time (an ability thought to be mediated by the right hemisphere) and joke funniness ratings and concluded that right hemisphere processing underlies humor appreciation. Coulson and Williams (2004) investigated humor with healthy adults using event-related potentials (ERPs). The N400 is an ERP component that is elicited by semantically anomalous information (Kutas & Hillyard, 1983). Jokes presented to the right visual field (left hemisphere) elicited N400s of larger amplitudes than non-jokes, but jokes presented to the left visual field (right hemisphere) elicited N400s of equal amplitude as non-jokes. The authors concluded that the right hemisphere integrates joke endings more easily than the left hemisphere.

The Frontal Lobes

The frontal lobes also may be related to humor perception. Using ratings of humorous and neutral written statements to investigate humor appreciation, Shammi and Stuss (1999) found that individuals with right frontal lobe damage had diminished mirth responses to the humorous material. The authors concluded that the right frontal lobe is necessary for integrating cognitive and affective information, and that humor appreciation involves the interpretation of current information based on past experience. Autism has been associated with left frontal dysfunction (Rinehart, Bradshaw, Brereton, & Tonge, 2002), and there is evidence that the left frontal lobe also contributes to humor appreciation. Ozawa et al. (2000) investigated cerebral activation related to humor and found that funny sentences presented auditorily were associated with activation in the left frontal area and the middle frontal gyrus. Goel and Dolan (2001) investigated humor in neurologically healthy individuals using event-related fMRI while the participants listened to jokes. They found that separate networks were activated for different types of humor. Direct comparisons of semantic and phonological joke conditions revealed that semantic jokes activated a bilateral temporal lobe network including the right posterior middle temporal gyrus and the left posterior inferior temporal gyrus, whereas phonological jokes activated a left hemisphere network involving the left inferior prefrontal cortex.

The Ventromedial Prefrontal Cortex

Although research investigating humor and the ventromedial prefrontal cortex (VMPFC) is sparse, this area may be involved with humor appreciation due to its role in

integrating emotional processes and modulating the expression of social and emotional behavior (Pietrini et al., 2000). Damasio (1994) argues that the VMPFC links complex situations and their associated somatosensory and emotional states and has the ability to reactivate an emotion when faced with a situation in which these states have been previously activated. Hence, the VMPFC mediates processes of integration between cognition and affective states (Adolphs, Tranel, & Damasio, 2003; Damasio, 1994, 1996; Damasio, Tranel, & Damasio, 1990) and is involved in emotion-related learning through its connection with the limbic system and amygdala (Rolls, Yanxley, & Sienkiewicz, 1990). Given that the VMPFC appears to have a role in attaching emotional valence to stimuli (Elliott, Dolan, & Frith, 2000; Kawasaki et al., 2001), reduced integrity of this area may affect its ability to represent the affective components of mental states, which would affect humor appreciation.

In one of the few studies directly investigating the role of the VMPFC in humor, Goel and Dolan (2001) attempted to examine comprehension and appreciation as separate components of humor using fMRI. They identified a distinct network for the appreciation of humor indicated by significant activation in the VMPFC and the bilateral cerebellum that correlated with post-scan funniness ratings of the humor stimuli. In another study of humor and the VMPFC, laughter and smiling associated with humor, as opposed to voluntary smiling, was associated with increased regional cerebral blood flow in the VMPFC (Iwase et al., 2002).

The VMPFC has been implicated in several studies of ToM (Baron-Cohen, 1995; Baron-Cohen et al., 1994; Berthoz, Armony, Blair, & Dolan, 2002; Eslinger, 1998;

Fletcher et al., 1995; Frith & Frith, 1999; Goel et al., 1995; Happe et al., 1996; Rowe et al., 2001; Sabbagh, Moulson, & Harkness, 2004; Shamay-Tsoory, Tomer, & Aharon-Peretz, 2002; Stone, Baron-Cohen, & Knight, 1998), which contributes to humor perception. Baron-Cohen et al. (1999) suggest that the VMPFC serves to integrate the cognitive and affective aspects of ToM in order to represent another person's affective state. In an fMRI investigation of ToM comparing ToM and non-ToM stories and cartoons, the medial prefrontal cortex was the only area uniquely activated in the ToM conditions (Gallagher et al., 2000). Damage to the VMPFC also has been associated with impaired irony detection and social faux-pas identification or affective ToM (Shamay-Tsoory, Tomer, & Aharon-Peretz, 2002; Shamay-Tsoory et al., 2005).

Somatic arousal is represented in the VMPFC, indicating that cognitive and emotional aspects of behavior are integrated with information regarding peripheral autonomic states of arousal in the VMPFC (Critchley et al., 2000). This is supported by evidence that damage to the left and right VMPFC is associated with defective electrodermal responding to socially significant stimuli and when making personal decisions (Bechara, Tranel, & Damasio, 2000; Tranel & Damasio, 1994). The VMPFC links categories of events based on previous experience and their associated somatic state. It is possible that the representations of affective information from the limbic system and information associated with somatic states are necessary elements in the processes by which cognitive and affective responses are integrated to permit humor appreciation.

The extensive bidirectional connections of the VMPFC and amygdala also support the proposition that the VMPFC has a role in humor appreciation. Humor results in activation of the amygdala (Mobbs et al., 2003; Moran et al., 2004). Moran et al. (2004) used event-related fMRI to dissociate humor comprehension from humor appreciation. Participants watched episodes of popular television sitcoms with laugh tracks included. Brain activity for events time-locked to moments preceding the laugh track was considered to be associated with humor comprehension, and brain activity for events time-locked to the laugh track was considered to be associated with humor appreciation. They found that humor comprehension was related to activation of inferior frontal and posterior temporal cortices, and humor appreciation was related to increased activation in the amygdala. The authors concluded that there are distinct neural networks for humor comprehension and humor appreciation.

CHAPTER 2

INTRODUCTION

Humor is a uniquely human trait that serves many functions in everyday life. The ability to appreciate humor facilitates social behavior and, therefore, has a vital role in social relationships. Humor is a social instrument that provides an effective way to reduce psychological distress (Keltner & Bonanno; 1997; Martin & Lefcourt, 1983; Overholser, 1992; Thorson, Powell, Sarmany-Schuller, & Hampes, 1997), communicate a range of feelings and ideas (Brownell & Gardner, 1988; Daws, Kaplan, & Winner, 1995; Dixon, 1980; Haig, 1986; Martin, 2001), and enhance relationships (Fraley & Aron, 2004; Haig, 1986; Mosak, 1987; Nezlek & Derks, 2001; Vinton, 1989). Brownell and Gardner (1988) assert that because humor provides a means of socialization that adds to one's enjoyment in life, any disruption of a person's ability to understand humor will negatively influence his/her overall quality of life.

Although the social benefits of humor are evident, the process of humor perception remains unclear. Humor perception has been used synonymously with humor comprehension in the literature, and some investigators have used it to denote both humor comprehension and humor appreciation. Ziv (1984) drew a distinction between two aspects of humor. Humor comprehension has been described as the ability to perceive relationships or ideas in incongruous ways, whereas humor appreciation has been defined as the ability to understand and get pleasure from humorous messages (Ziv, 1984). Research has attempted to explore the processes involved in humor perception through investigations with clinical populations who exhibit deficits in humor perception and

through studies of non-clinical samples. Clinical research has focused on both patients with acquired hemispheric lesions as well as those with developmental disorders (high functioning autism, Asperger syndrome, and Nonverbal Learning Disability). A number of possible correlates of humor perception have been investigated including both cognitive and physiological variables.

Cognitive Processes Related to Humor

Studies of brain injured individuals have suggested that deficits in particular cognitive processes accompany impaired humor perception. Visual-spatial reasoning and concept formation have been related to performance on tests of humor comprehension (Bihrl, Brownell, Powelson, & Gardner, 1986; Brownell, Michel, Powelson, & Gardner, 1983; Dagge & Hartje, 1985; Gillikin & Derks, 1991). The research of Shammi and Stuss (1999) suggests that different types of humor may require different underlying cognitive abilities. They found that performance on a measure of working memory was positively related to both the verbal (jokes) and nonverbal (cartoon) comprehension tests of humor in patients with left frontal and right frontal brain damage. In addition, verbal humor was related to verbal abstraction ability and mental flexibility, whereas nonverbal humor was related to visual attention.

Research with developmental disorders suggests that Theory of Mind (ToM) also may contribute to humor perception. ToM is the ability to conceive of others' mental states (Baron-Cohen, Leslie, & Frith, 1985). It is possible that humor appreciation requires an understanding of others' intentions and emotional states (Shamay-Tsoory, Tomer, & Aharon-Peretz, 2005). In order to fully understand humorous stimuli, it may be

necessary to take the perspectives of the characters to appreciate their feelings. ToM also allows people to view a situation from different perspectives, which may enhance the enjoyment of humorous material. The social deficits in high functioning autism and Asperger syndrome have been associated with impaired ToM abilities (Baron-Cohen et al., 1999), and there is a strong correlation between ToM abilities and the ability to explain non-literal messages such as jokes, irony, and sarcasm (Happe, 1993, 1994). To detect irony, inferences must be made about the speaker's knowledge and intensions (Dews & Winner, 1997; McDonald, 1999; Winner, 1998), suggesting that ToM is an underlying process of humor perception. Impairment in the pragmatic aspects of language, another characteristic of autism and Asperger syndrome (Tager-Flusberg, 1981), affects social communication and verbal humor perception (Happe, 1993, 1994; Minshew, Goldstein, & Siegel, 1995). There is general agreement that pragmatics and ToM are closely associated (Dunn, Brown, Slomkowski, Tesla, & Youngblade, 1991; Happe, 1995; Tager-Flusberg, 1997), providing further evidence that ToM abilities are important in humor perception.

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appreciation of humor, and investigations of these affective processes have focused on fluctuations in physiological arousal. Upon hearing a funny joke, the body experiences increased heart rate and skin conductance response, and this arousal is followed by a strong, positive affective reaction (humor response) (Godkewitsch, 1996; Goldstein, Harman, McGhee, & Karasik, 1975; Katz, 1993; Langevin & Day, 1972; McGhee, 1983), suggesting that physiological arousal also may be a critical component of the experience of humor, and that the appreciation of humor may require the integration of cognitive and affect information.

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Studies of individuals with developmental disorders, patients with acquired brain lesions, and neurologically healthy participants provide several converging lines of evidence that support the hypothesis that the right hemisphere is specialized for processing a variety of socioemotional stimuli including humorous material (Gainotti, 1972; Gardner, Ling, Flamm, & Silverman, 1975; Shammi & Stuss, 1999). Patients with right hemisphere strokes perform worse than those with left hemisphere strokes on tasks of verbal and nonverbal humor appreciation and emotional responsiveness to humorous

stimuli (Shammi & Stuss, 1999; Wapner, Hamby, & Gardner, 1981). Asperger syndrome and nonverbal learning disorder have been associated with cognitive impairments that implicate right hemisphere deficits such as difficulty interpreting nonverbal social cues and impaired visual-spatial-organizational abilities (Berthier, Bayes, & Tolosa, 1993; Ellis, Ellis, Fraser, & Deb, 1994; Ellis & Gunter, 1999; Gunter, Ghaziuddin, & Ellis, 2002; Johnson & Myklebust, 1967; McKelvey, Lambert, Mottron & Shevell, 1995; Rourke & Finlayson, 1978; Rourke & Strang, 1978; Rourke & Telegdy, 1971; Volkmar et al., 1996), and, as previously noted, both groups demonstrate impaired humor perception. They also have difficulty integrating information to construct a global meaning (an ability attributed to the right hemisphere), which is necessary for getting the general idea of a joke (Frith, 1989; Happe, 1997; Jolliffe & Baron-Cohen, 2000).

Studies of healthy adults also have found links between humor perception and indices of right hemisphere functioning. Johnson (1990) found a positive correlation between mental rotation time (an ability thought to be mediated by the right hemisphere) and joke funniness ratings and concluded that right hemisphere processing underlies humor appreciation. Using event-related potentials (ERPs), Coulson and Williams (2004) found that jokes presented to the right visual field (left hemisphere) elicited N400s of larger amplitudes than non-jokes, but jokes presented to the left visual field (right hemisphere) elicited N400s of equal amplitude as non-jokes. The authors concluded that the right hemisphere integrates joke endings more easily than the left hemisphere.

The frontal lobes also may be related to humor perception. There is evidence that both the left and right frontal lobes contribute to humor appreciation. Autism has been

associated with left frontal dysfunction (Rinehart, Bradshaw, Brereton, & Tonge, 2002). Right frontal lobe damage has been associated with diminished mirth responses to humorous material (Shammi & Stuss, 1999). Ozawa et al. (2000) found that funny sentences presented auditorily were associated with activation in the left frontal area and the middle frontal gyrus. Using event-related fMRI, Goel and Dolan (2001) found that separate networks were activated for different types of humor. Semantic jokes activated a bilateral temporal lobe network including the right posterior middle temporal gyrus and the left posterior inferior temporal gyrus, whereas phonological jokes activated a left hemisphere network involving the left inferior prefrontal cortex.

The ventromedial prefrontal cortex (VMPFC) may be involved with humor appreciation due to its role in integrating emotional processes and modulating the expression of social and emotional behavior (Pietrini et al., 2000). The VMPFC mediates processes of integration between cognition and affective states (Adolphs, Tranel, & Damasio, 2003; Damasio, 1994, 1996; Damasio, Tranel, & Damasio, 1990) and is involved in emotion-related learning through its connection with the limbic system and amygdala (Rolls, Yanxley, & Sienkiewicz, 1990). Somatic arousal is represented in the VMPFC, indicating that cognitive and emotional aspects of behavior are integrated with information regarding peripheral autonomic states of arousal in the VMPFC (Critchley et al., 2000). Goel and Dolan (2001) identified a distinct network for the appreciation of humor indicated by significant activation in the VMPFC and the bilateral cerebellum that correlated with post-scan funniness ratings of the humor stimuli. Increased regional cerebral blood flow in the VMPFC has also been related to laughter and smiling

associated with humor as opposed to voluntary smiling (Iwase et al., 2002). The VMPFC also has been implicated in several studies of Theory of Mind (ToM) (Baron-Cohen, 1995; Baron-Cohen et al., 1994; Berthoz, Armony, Blair, & Dolan, 2002; Eslinger, 1998; Fletcher et al., 1995; Frith & Frith, 1999; Goel et al., 1995; Happe et al., 1996; Rowe et al., 2001; Sabbagh, Moulson, & Harkness, 2004; Shamay-Tsoory, Tomer, & Aharon-Peretz, 2002; Stone, Baron-Cohen, & Knight, 1998), which contributes to humor perception.

The Present Study

Humor is a multifaceted construct. Most of the extant humor research has focused on humor comprehension with only a few studies investigating humor appreciation as a separate construct. Humor is not an inherent property of a situation. Rather, it is determined by the perception of the observer. Not everything that contains the potential elements of humor is perceived as humorous or leads to amusement; therefore, both humor comprehension and humor appreciation were investigated in the present study. First, the relations between verbal and nonverbal humor and specific cognitive processes were investigated. Given the evidence that different types of verbal humor have been associated with different neural networks, two kinds of verbal humor, semantic and phonological, were explored. With one exception, the cognitive processes selected for inclusion in the present study were those that have been identified as potential correlates of humor perception in previous studies of clinical populations and specific measures were selected with the goal of assessing these constructs. Given the importance of the ability to detect incongruity in theoretical models of humor perception, the present study

also included a measure of inhibition that requires the detection and resolution of response competition.

Second, this study investigated the relationship between humor comprehension and humor appreciation. It was hypothesized that humor comprehension would be positively correlated with humor appreciation, but that the ability to integrate cognitive and affective information also would contribute significantly to humor appreciation by moderating this relationship. Thus, the present study utilized two behavioral tasks previously linked to VMPFC functioning to explore the possible contribution of the VMPFC to humor appreciation. There are differences in emotion regulation and decision-making among neurologically intact individuals, which suggests that there are differences in the integrity of the VMPFC in the general population (Bechara, Damasio, Tranel, & Damasio, 1997; Bechara, Tranel, Damasio, & Damasio, 1996; Crone, Somsen, Van Beek, & van Der Molen, 2004; Jackson et al., 2003). The VMPFC is part of a neural network that mediates performance on the Iowa Gambling Task (IGT); therefore, this task has been used to assess VMPFC functioning in patients (Bechara et al., 1994, 2003; Bolla et al., 2003; Ernst et al., 2002; Manes et al., 2002) and in the general population (Fishbein et al., 2005; Suzuki, Hirota, Takasawa, & Shiegemasu, 2003). Theory of mind is another function of the VMPFC (Baron-Cohen, 1995; Baron-Cohen et al., 1994; Berthoz, Armony, Blair, & Dolan, 2002; Eslinger, 1998; Fletcher et al., 1995; Frith & Frith, 1999; Gallagher et al., 2000; Goel et al., 1995; Happe et al., 1996; Rowe et al., 2001; Sabbagh, Moulson, & Harkness, 2004; Shamay-Tsoory, Tomer, & Aharon-Peretz, 2002; Shamay-Tsoory et al., 2005; Stone, Baron-Cohen, & Knight, 1998). There is evidence that the

VMPFC serves to integrate the cognitive and affective aspects of ToM in order to represent another person's affective state (Baron-Cohen et al., 1999). The present study used the IGT and a set of ToM cartoons as indicators of VMPFC function.

Previous research primarily has utilized humor inventories, self-report, joke-stem completion tasks, and pictorial cartoon tasks to investigate humor comprehension and appreciation. Although these measures are capable of assessing some aspects of humor appreciation, the stimuli are often static which affects their ecological validity. Humor inventories and self-report may be further confounded by the participants' levels of metacognition. In the present study, humorous stimuli were presented in the form of prerecorded jokes and film clips.

Hypotheses

Neuropsychological Profiles and Humor Comprehension

It was hypothesized that the comprehension of verbal and nonverbal humor would be predicted by different yet overlapping neuropsychological profiles. Specifically, it was predicted that measures of cognitive flexibility, inhibition, and concept formation would be predictive of comprehension scores of both types of humor; however, measures of auditory working memory and verbal reasoning would be predictive of only verbal humor, and measures of visual working memory and visual-spatial reasoning would be predictive of only nonverbal humor.

When verbal humor was divided into phonological and semantic categories, it was expected that measures of auditory working memory, cognitive flexibility, and inhibition would be predictive of comprehension scores of both kinds of verbal humor, but

measures of concept formation and verbal reasoning would be predictive of only semantic humor.

Humor Appreciation and the Ventromedial Prefrontal Cortex

It was predicted that performances on the IGT and the ToM cartoon task would moderate the relationship between humor comprehension and affective ratings. Higher performances on the IGT and the ToM cartoon task would strengthen the relationship between joke comprehension and appreciation. That is, the predictive relationship between comprehension scores and affective ratings would increase as a function of increased performances on the IGT and ToM cartoon task.

CHAPTER 3

METHODS

Participants

An a priori power analysis was conducted to determine the sample size. The parameters of the power analysis were as follows: effect size = .18, alpha level = .05, power = .80, predictors = 7. Ninety-four undergraduate psychology students at Georgia State University between the ages of 18 and 39 years old were recruited for this study. A second sample of seventy-seven undergraduate psychology students at Georgia State University were recruited to participate in a cross validation study for the humor comprehension/appreciation inventory. Participants were between the ages of 18 and 36. The participants in both the study sample and cross validation sample were told that they were participating in a study of humor perception and were offered class credit for their participation. Table 1 presents demographic characteristics for the study sample and cross validation sample.

Table 1
Demographic Comparisons of the Study Sample and Cross Validation Sample

	Study Sample	Cross Validation Sample
N	94	77
Age		
M (SD)	20.44 (3.89)	20.39 (3.10)
Gender (% Female)	61.7	68.8
Ethnicity (% Non-Caucasian)	46.8	53.2
Handedness (% Non-Right)*	2.1	9.1

Note. Handedness was determined by participant report.
*$p<.05$

Measures

Humor Stimuli

To select the humor stimuli for the present study, audio and video tapes depicting humor were initially reviewed, and possible joke and film candidates were compiled. Fifty-six jokes were chosen on the basis of their phonological and semantic characteristics. Twenty-eight film clips were chosen based on the presence of brief, discrete incidents of physical humor. A focus group composed of doctoral students in psychology reviewed the selections and identified those that were either ambiguous or made reference to religion, sex, or politics. Thirteen jokes and nine film clips identified by the focus group were eliminated from the compilation of stimuli to be used in this study. Multiple choice response options for the humor comprehension questions were devised by the researcher, and their construction was based on elements of the humor stimuli that were not intended to be the primary humorous aspects. The focus group reviewed these options for relevance and clarity and revised them accordingly. Three undergraduate students in psychology reviewed the multiple choice responses for intelligibility. Each of these students indicated that the multiple choice options were clear and understandable.

Verbal Stimuli

The humorous verbal stimuli were pre-recorded jokes from *A Prairie Home Companion Pretty Good Joke Tape* (2004). Twenty-seven of the jokes were phonological jokes (puns), and 16 were semantic jokes (jokes in which the humor depends on factors other than simple word play). The summed recorded duration of the phonological jokes

was equivalent to that of the semantic jokes and totaled two minutes. The stimuli were presented with the laugh track removed.

Nonverbal Stimuli

The humorous film clips consisted of one two-minute presentation of a *Mr. Bean* video (*Bean The Movie, 2002)* and one two-minute presentation of *Charlie Chaplin* video (*Modern Times,* 2003). The films were divided into brief segments depicting discrete incidents of humor. The *Mr. Bean* film footage was divided into ten segments, and the *Charlie Chaplin* film footage was divided into nine segments. The film clips were presented without sound.

Questionnaire

Humor Comprehension/Appreciation Inventory

After the presentation of each joke and after each discrete segment of the humorous films, the participants were asked to rate how funny they found the material on a seven point Likert-type scale as a measure of humor appreciation. They were then asked to indicate whether or not they understood ("got") the humor. Next, they selected the humorous aspect of the stimulus from five multiple choice options. If they were unsure of the humorous aspect, they could choose an option indicating that they were unsure. Only one of the multiple choice options was correct. The humor comprehension score for each participant was the summed number of correct answers, and the humor appreciation score was the summed ratings for the items. The mean comprehension scores and appreciation scores for each type of humorous stimuli were calculated. The

humor appreciation rating scale and the multiple choice options for each of the humor stimuli are presented in Appendix A.

Cognitive Measures

The measures used to assess the cognitive abilities related to humor comprehension are presented in Table 2.

Table 2
Cognitive Measures

Area	Measure
Auditory Working Memory	Wechsler Memory Scale-III Digit Span
Visual Working Memory	Wechsler Memory Scale-III Spatial Span
Verbal Reasoning	Wechsler Adult Intelligence Scale-III Similarities
Visual-Spatial Reasoning	Woodcock Johnson-3 Spatial Relations
Cognitive Flexibility	Delis-Kaplan Executive Function System Trail Making Test
Concept Formation	Delis-Kaplan Executive Function System Sorting Test
Inhibition	Delis-Kaplan Executive Function System Color-Word Interference Test
VMPFC Function	Iowa Gambling Task
	Theory of Mind Cartoons

Note. VMPFC = Ventromedial Prefrontal Cortex.

Auditory Working Memory

WMS-3 Digit Span (Wechsler, 1997). The Digit Span subtest of the WMS-3 is a measure of auditory attention span/working memory. It assesses the ability to process, mentally track, and manipulate auditory information.

Visual Working Memory

WMS-3 Spatial Span (Wechsler, 1997). The Spatial Span subtest of the WMS-3 is a measure of visual attention span/working memory. It assesses the ability to process, mentally track, and manipulate visual information.

Verbal Reasoning

WAIS-3 Similarities (Wechsler, 1997). The Similarities subtest of the WAIS-3 requires categorization and the ability to ascertain abstract relationships. It was used to measure verbal abstract reasoning.

Visual-Spatial Reasoning

WJ-3 Spatial Relations (Woodcock, Mather, & McGrew, 2001). The Spatial Relations subtest of the WJ-3 requires visual discrimination, analysis, and synthesis. It was used to measure visual-spatial abstract reasoning.

Cognitive Flexibility

D-KEFS Trail Making Test (Delis, Kaplan, & Kramer, 2001). The Number-Letter Switching subtest of the Trail Making Test is a task requiring the participant to draw lines to connect alternating sequences of 13 letters and 13 numbers consecutively. This test measures visual search ability, attention, mental flexibility, and motor speed. To remove the potentially confounding effect of deficient letter or number sequencing, the number-letter switching versus combined number sequencing and letter sequencing contrast score was used.

Concept Formation

D-KEFS Sorting Test (Delis, Kaplan, & Kramer, 2001). The Sorting Test is a measure of concept formation and problem solving. Participants are required to sort six cards into two groups with three cards in each group. The three cards in each group must be the same in some way, requiring the participant to use verbal and/or perceptual sorting principles. The raw score is the summed points for the descriptions of the sorting rules.

Inhibition

D-KEFS Color Word Interference Test (Delis, Kaplan, & Kramer, 2001). The Color Word Interference Test is a measure of inhibition that requires the inhibition of a pre-potent verbal response in order to generate a conflicting response. Names of colors are printed in dissonant ink colors. Participants are required to say the color of ink in which the word is printed rather than read the word, which is a more automatic response. To remove the potentially confounding effect of deficient naming speed, the inhibition versus color naming contrast score was used.

Ventromedial Prefrontal Cortex Functioning

Iowa Gambling Task (Bechara, Damasio, Damasio, & Anderson, 1994). A computerized version of the Iowa Gambling Task was used as an indicator of the ventromedial prefrontal cortex function of linking knowledge about previous experiences and information to feelings associated with the body states. On this task, the participants were instructed to win as much money as possible by picking one card at a time from each of four decks in any order until the computer instructed them to stop. They were told that some decks were advantageous while others were disadvantageous. While performing the task, the participants were informed of the amount of money they had after each card was selected. An outcome score was calculated by subtracting the total number of cards selected from the disadvantageous decks from the total number of cards selected from the advantageous decks. Initially, analyses were conducted with IGT performance as a continuous variable. A median split also was used to divide the scores into high and low performance groups.

Theory of Mind Cartoons (Gallagher et al. 2000). Theory of mind cartoons were used as a second potential indicator of ventromedial prefrontal cortex function. A total of 14 cartoons without captions were presented individually to each participant. All of the cartoons supported an inference of false belief/ignorance. The participants were asked to explain why each cartoon was funny. Their responses were recorded, transcribed, and scored by independent raters. Their answers were scored according to a standard scoring scheme with three points given for an explicit explanation, two points given for an implicit explanation, one point given for reference to relevant parts of the cartoon without further explanation, and zero points given for incorrect answers or a failure to answer. Examples of answers and their scoring are given in Appendix B This scoring scheme was adopted from Happe et al. (2001) and has been associated with good inter-rater agreement (Happe, Brownell, & Winner, 1999). All responses to the ToM cartoons were rated independently by two graduate students. Kappas ranged from .67 to 1.00 for 13 of the 14 items with only one item falling below that level (.46) (see Table 3). Disagreements were resolved through discussion in which both raters stated their rationale for their ratings and came to a resolution.

Table 3
Inter-Rater Reliability (Kappa) for Theory of Mind Cartoons

Cartoon	Kappa
ToM Cartoon 1	1.00
ToM Cartoon 2	0.98
ToM Cartoon 3	0.98
ToM Cartoon 4	1.00
ToM Cartoon 5	0.46
ToM Cartoon 6	0.97
ToM Cartoon 7	0.67
ToM Cartoon 8	0.85
ToM Cartoon 9	0.85
ToM Cartoon 10	0.75
ToM Cartoon 11	0.85
ToM Cartoon 12	0.85
ToM Cartoon 13	0.93
ToM Cartoon 14	0.68
Mean kappa	0.78

Procedure

All participants were tested individually in one experimental session lasting approximately two hours. When the participants arrived at the lab, the experimenter explained the procedure to them and asked them to sign the informed consent form (Appendix C). The participants were told that they would be watching film clips, listening to jokes, completing several cognitive tasks, and playing various games.

The humorous stimuli were presented in digital format on computer. The semantic and phonological jokes were presented in random order in one block, and all participants heard the jokes in the same sequence. The two genres of film clips were counterbalanced in one block such that half of the participants saw the *Mr. Bean* clips prior to the *Charlie Chaplin* clips, and the other half of the participants viewed the film clips in the opposite order. In the presentation of the humor tasks, the block of jokes and the block of film clips were counterbalanced. That is, for half of the participants, the film clips were

presented before the jokes, and for the other half of the participants, the jokes were presented before the film clips. The individual neuropsychological tests, including the gambling task and the ToM cartoons, occurred in random order across participants. The presentation of the experimental tasks (humor tasks and neuropsychological tests) was counterbalanced across participants.

Overall Design

Part I: Humor Comprehension/Appreciation Inventory. Descriptive statistics were computed to characterize performance on the humor inventory. Paired sample t-tests were used to compare differences in the participants' comprehension and appreciation of the different types of humor. Correlational analyses were used for initial examination of the relationships among the humor variables and among humor variables and demographic variables. As an indicator of reliability, coefficient alpha was computed for each of the humor comprehension and appreciation scales. These analyses were completed for both the original study sample and the cross-validation sample. Univariate ANOVAs were used to compare the study sample and the cross validation sample on demographic characteristics and humor inventory performance.

Part II: Neuropsychological Profiles and Humor. Hierarchical regression analyses were used to test the hypothesized relationships between the neuropsychological variables and the comprehension scores for the verbal and nonverbal humor stimuli. Separate regression analyses also were conducted for the two types of verbal humor stimuli (i.e., phonological and semantic). Demographic variables that were significantly correlated with performance on the humor inventory were entered in step one of the

analyses. The variables expected to be predictive of only one type of humor (measures of auditory working memory and verbal reasoning for verbal humor and measures of visual working memory and visual-spatial reasoning for nonverbal humor) were entered in step two of the analyses. The three variables expected to be predictive of both kinds of humor (measures of cognitive flexibility, inhibition, and concept formation) were entered in the next step of the analyses, and the variables that were not expected to contribute significantly to the humor comprehension model (measures of visual working memory and visual-spatial reasoning for verbal humor and measures of auditory working memory and verbal abstraction for nonverbal humor) were entered in the final step of the analyses.

Part III: Humor Appreciation and the Ventromedial Prefrontal Cortex.

Hierarchical regression analyses were employed to test the hypothesis that VMPFC functioning moderates the relationship between the comprehension of humor and humor appreciation. Two parallel analyses were conducted, one using the Iowa Gambling Task as the measure of VMPFC function and the other using the Theory of Mind task. Demographic variables that were significantly correlated with humor inventory performance were entered in step one. Humor comprehension and the measure of VMPFC function were entered in steps two and three of the model, followed by a term representing their interaction in step four to explore possible moderation.

CHAPTER 4

RESULTS

Data Screening

Scores on the neuropsychological tests and the humor inventory were screened for outliers. Outliers were adjusted to fall one unit outside the next closest score in the distribution. On the neuropsychological measures, there were six outliers from five separate participants. These outliers were found on Digit Span, Spatial Span, the Trail Making Test, the Color Word Interference Test, and the Sorting Test. There were two outliers on each humor comprehension scale (nonverbal, semantic, and phonological) from five separate participants. Inspection of the distribution of scores for each of the measures demonstrated some deviations from normality. Log 10 and square root transformations were applied to the variables. In general, results of analyses run with and without the transformations did not yield different results. Therefore, results based on untransformed data are reported.

Descriptive statistics for the cognitive variables are presented in Table 4, and intercorrelations among demographic and neuropsychological variables are presented in Table 5. None of the demographic variables showed a consistent pattern of significant correlations across multiple cognitive measures. Ethnicity was correlated significantly with a measure of auditory working memory with non-Caucasians having lower scores on this task than Caucasians. Ethnicity also was correlated significantly with the IGT and the ToM task with non-Caucasians performing below Caucasians on the IGT and better than Caucasians on the ToM task. Gender was correlated significantly with a measure of

visual working memory with females having lower scores on this task than males. Age was positively correlated with a measure of verbal reasoning. Interestingly, intercorrelations among the cognitive measures were lower than would be expected.

Table 4
Descriptive Statistics for Cognitive Measures

Measure	N	Mean	SD	Min.	Max.
Digit Span	94	17.80	4.00	10	29
Spatial Span	94	16.59	3.07	10	24
Similarities	94	21.91	4.04	12	30
Spatial Relations	94	71.89	4.91	59	81
Trails Switching	94	8.74	1.84	4	14
Sorting Description	94	37.83	6.64	21	56
Color Word Inhibition	94	10.70	2.19	5	14
IGT	94	14.78	29.94	-65	68
ToM Cartoons	94	29.89	4.95	15	40

Note. Digit Span = Wechsler Memory Scale-III Digit Span raw score, Spatial Span = Wechsler Memory Scale-III Spatial Span raw score, Similarities = Wechsler Adult Intelligence Scale-III Similarities raw score, Spatial Relations = Woodcock Johnson-3 Spatial Relations raw score, Trails = Delis-Kaplan Executive Function System Trails Number-Letter Switching vs. Combined Number Sequencing and Letter Sequencing contrast score, Sorting Description= Delis-Kaplan Executive Function System Free Sorting Description raw score, Color Word Inhibition = Delis-Kaplan Executive Function System Color Word Interference Inhibition vs. Color Naming contrast score, IGT = Iowa Gambling Task total number of cards selected from the disadvantageous decks subtracted from the total number of cards selected from the advantageous decks, ToM Cartoons = Theory of Mind Cartoons sum of ratings.

Table 5
Intercorrelations Among Demographic and Cognitive Variables

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Age	1.00												
2. Gender	-.27**	1.00											
3. Ethnicity	-.06	-.09	1.00										
4. Handedness	.00	-.03	-.02	1.00									
5. Digit Span	-.03	-.13	-.24*	.12	1.00								
6. Spatial Span	-.06	-.25*	.09	-.05	.18	1.00							
7. Similarities	.25*	-.07	-.06	-.01	.04	.10	1.00						
8. Trails Switching	.12	.08	-.20	.10	.22*	-.07	.16	1.00					
9. Color Word Inhibition	.05	.07	-.15	.04	.06	.10	-.06	.00	1.00				
10.Sorting Description	-.13	-.02	.03	-.05	-.02	.14	.05	-.02	-.10	1.00			
11.Spatial Relations	-.05	-.08	-.14	-.06	.12	.32**	.23*	.05	-.08	.30**	1.00		
12.IGT	.03	-.15	-.25*	-.27**	.07	-.02	.17	.04	-.11	-.07	.13	1.00	
13. ToM Cartoons	.07	-.08	.21*	.00	.14	.19	.14	-.02	.18	.07	.28**	-.10	1.00

Note. Digit Span = Wechsler Memory Scale-III Digit Span, Spatial Span = Wechsler Memory Scale-III Spatial Span, Similarities = Wechsler Adult Intelligence Scale-III Similarities, Spatial Relations = Woodcock Johnson-3 Spatial Relations, Trails = Delis-Kaplan Executive Function System Trail Making Test, Sorting Description= Delis-Kaplan Executive Function System Sorting Test, Color Word Inhibition = Delis-Kaplan Executive Function System Color-Word Interference Test, IGT = Iowa Gambling Task, ToM Cartoons = Theory of Mind Cartoons.
*p<.05; p<.01

Part I: Humor Comprehension/Appreciation Inventory

Descriptive statistics characterizing performance on the Humor Comprehension/Appreciation Inventory for both the original study sample and the cross-validation sample are presented in Table 6. The only demographic variable on which the study sample and the cross validation sample differed was handedness with the cross validation sample having a larger proportion of individuals who were not right handed $F(1, 171) = 4.17$, $p < .05$. Comparisons of the study sample and cross validation sample performance on the humor variables yielded no significant group differences.

Table 6

Group Comparisons on Humor Variables

	Study Sample	Cross Validation Sample
Total Humor Appreciation	179.93 (55.88)	170.16 (50.53)
Total Humor Comprehension	42.00 (7.75)	40.38 (8.84)
Nonverbal Humor Appreciation	66.64 (22.33)	62.91 (24.06)
Nonverbal Humor Comprehension	14.39 (1.95)	13.99 (2.16)
Verbal Humor Appreciation	113.29 (40.25)	107.25 (41.21)
Verbal Humor Comprehension	27.52 (6.85)	26.39 (8.05)
Semantic Verbal Humor Appreciation	46.98 (16.31)	43.60 (15.78)
Semantic Verbal Humor Comprehension	11.83 (1.97)	11.16 (2.67)
Phonological Verbal Humor Appreciation	66.31 (25.07)	63.65 (26.66)
Phonological Verbal Humor Comprehension	15.70 (5.60)	15.23 (6.05)

Note. Univariate ANOVAs were used to compare the variables and no significant differences were present.

Additional psychometric data for the Humor Inventory in the original study sample are presented in Tables 7 and 8. Coefficient alpha was computed for each of the humor comprehension and appreciation scales. The alpha coefficients were low for the

nonverbal and semantic humor comprehension scales. Alpha is determined by the interrelatedness of the items in a scale as well as the number of items in a scale (Oliver & Benet-Martinez, 2000); thus, it can be problematic to interpret alpha without considering the length of the scale. The phonological humor scales have eleven more items than the semantic humor scales and eight more items than the nonverbal humor scales. To remove differences among the intercorrelations that were simply due to discrepant reliability, alpha was used to correct the observed correlations between the scales. Parallel data for the combined study and cross-validation samples are presented in Table 9 and 10 and are quite similar to the study sample data.

Table 7
Alpha Coefficients, Observed Correlations, and Corrected Correlations Among the Humor Inventory Comprehension Scales

Scales	TH	VH	NVH	SH	PH
Total Humor (TH)	(.85)	--	--	--	--
Verbal Humor (VH)	.98	(.85)	.83	--	--
Nonverbal Humor (NVH)	.64	.47	(.38)	.88	.77
Semantic Humor (SH)	.70	.71	.38	(.47)	.83
Phonological Humor (PH)	.94	.97	.44	.52	(.85)

Note. N = 94. Alpha coefficients are presented on the diagonal, observed correlations below the diagonal, and correlations corrected for attenuation above the diagonal.

Table 8
Alpha Coefficients, Observed Correlations, and Corrected Correlations Among the Humor Inventory Appreciation Scales

Scales	TH	VH	NVH	SH	PH
Total Humor (TH)	(.97)	--	--	--	--
Verbal Humor (VH)	.94	(.97)	.58	--	--
Nonverbal Humor (NVH)	.80	.56	(.96)	.56	.54
Semantic Humor (SH)	.92	.96	.57	(.92)	.94
Phonological Humor (PH)	.92	.98	.52	.89	(.96)

Note. N = 94. Alpha coefficients are presented on the diagonal, observed correlations below the diagonal, and correlations corrected for attenuation above the diagonal.

Table 9
Alpha Coefficients, Observed Correlations, and Corrected Correlations Among the Humor Inventory Comprehension Scales for the Combined Study Sample and Cross Validation Sample

Scales	TH	VH	NVH	SH	PH
Total Humor (TH)	(.86)	--	--	--	--
Verbal Humor (VH)	.97	(.87)	.61	--	--
Nonverbal Humor (NVH)	.57	.37	(.43)	.67	.53
Semantic Humor (SH)	.76	.77	.34	(.60)	.78
Phonological Humor (PH)	.94	.97	.33	.58	(.89)

Note. N = 171. Alpha coefficients are presented on the diagonal, observed correlations below the diagonal, and correlations corrected for attenuation above the diagonal.

Table 10
Alpha Coefficients, Observed Correlations, and Corrected Correlations Among the Humor Inventory Appreciation Scales for the Combined Study Sample and Cross Validation Sample

Scales	TH	VH	NVH	SH	PH
Total Humor (TH)	(.97)	--	--	--	--
Verbal Humor (VH)	.95	(.97)	.67	--	--
Nonverbal Humor (NVH)	.85	.64	(.96)	.74	.60
Semantic Humor (SH)	.94	.95	.69	(.91)	.94
Phonological Humor (PH)	.91	.98	.58	.88	(.96)

Note. N = 171. Alpha coefficients are presented on the diagonal, observed correlations below the diagonal, and correlations corrected for attenuation above the diagonal.

Paired sample t-tests were conducted to investigate differences in the participants' comprehension and appreciation of the different types of humor with both samples. As shown in Figure 1, the mean comprehension score for the nonverbal humor was significantly greater than for verbal humor in both the study sample $t(93) = 7.99$, $p < .001$ and the cross validation sample $t(76) = 5.57$, $p < .001$, and the comprehension of semantic verbal humor was greater than phonological verbal humor in the study sample $t(93) = 8.42$, $p < .001$ and cross validation sample $t(76) = 6.84$, $p < .001$. As seen in

Figure 2, the affective ratings of nonverbal humor were greater than those of verbal humor in both the study sample $t(93) = 8.34$, $p < .001$ and the cross validation sample $t(76) = 7.27$, $p < .001$, and the affective ratings of semantic verbal humor were greater than the affective ratings of phonological verbal humor for the study sample $t(93) = 9.93$, $p < .001$ and the cross validation sample $t(76) = 6.62$, $p < .001$.

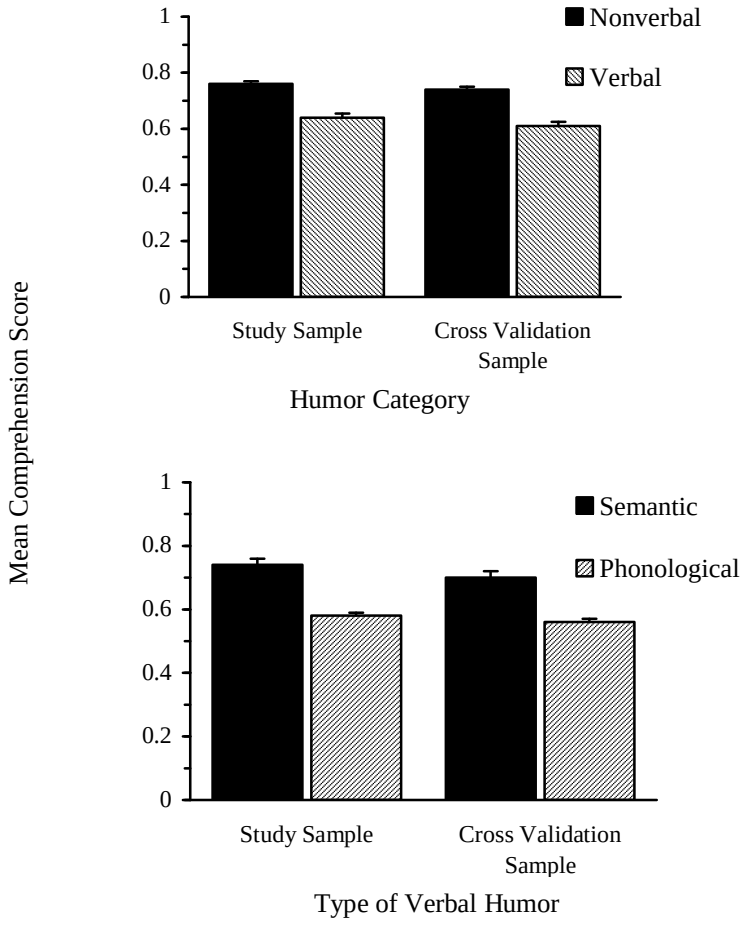

Figure 1
Mean comprehension scores of verbal and nonverbal humor and mean comprehension scores of semantic and phonological verbal humor.

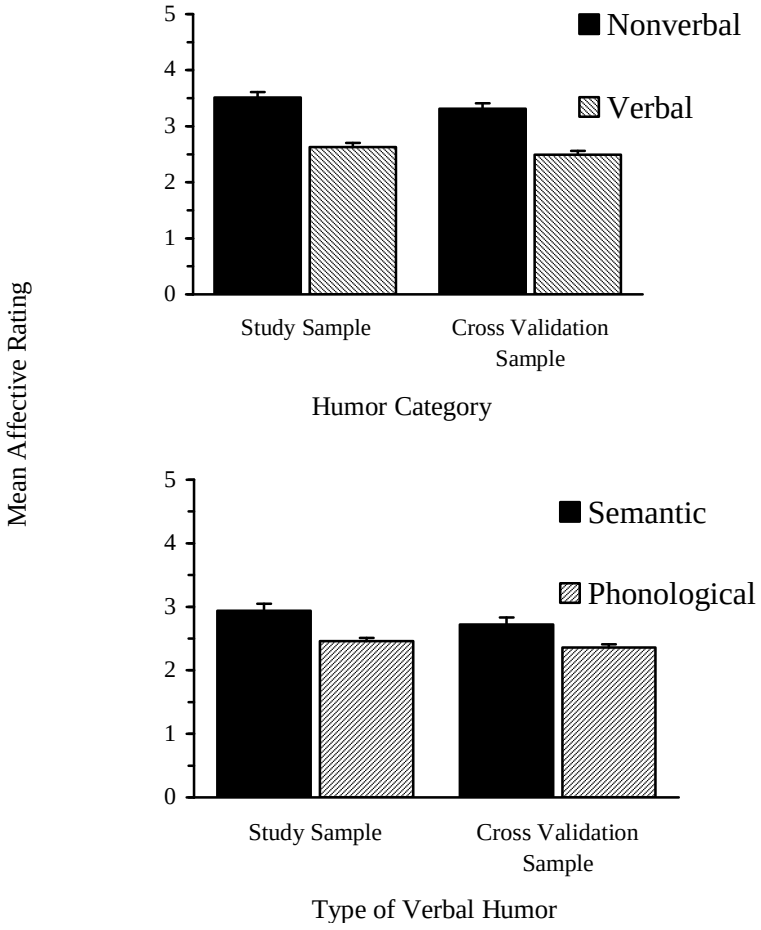

Figure 2
Mean affective ratings of verbal and nonverbal humor and mean affective ratings of semantic and phonological verbal humor.

Intercorrelations among humor inventory variables and between demographic and humor variables are presented in Table 11. The affective ratings of each type of humor were significantly correlated as were the comprehension scores. However, the affective ratings of the different types of humor were not significantly related to the participants' comprehension scores. Performance on the verbal items of the humor inventory was significantly related to demographic variables. Phonological humor comprehension was

Table 11
Intercorrelations Among Demographic and Humor Variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Age	1.00													
2. Gender	-.27**	1.00												
3. Ethnicity	-.06	-.09	1.00											
4. Handedness	.00	-.03	-.02	1.00										
5. Total Humor Appreciation	.05	-.06	.06	.06	1.00									
6. Total Humor Comprehension	.20*	-.15	-.28**	-.08	.04	1.00								
7. Nonverbal Appreciation	.05	-.17	.05	.11	.80**	-.05	1.00							
8. Nonverbal Comprehension	.07	-.10	-.08	.05	.08	.64**	-.02	1.00						
9. Verbal Appreciation	.04	.01	.06	.02	.94**	.09	.56**	.12	1.00					
10. Verbal Comprehension	.22*	-.13	-.30**	-.10	.04	.98**	-.05	.47**	.08	1.00				
11. Semantic Appreciation	.05	-.01	.10	.02	.92**	.05	.57**	.10	.96**	.04	1.00			
12. Semantic Comprehension	.08	.11	-.33**	-.06	.13	.70**	.02	.38**	.17	.71**	.15	1.00		
13. Phonological Appreciation	.04	.02	.03	.02	.92**	.11	.52**	.12	.98**	.10	.89**	.06	1.00	
14. Phonological Comprehension	.24*	-.20*	-.25*	-.10	-.01	.94**	-.07	.44**	.03	.97**	-.01	.52**	.06	1.00

*p<.05; p<.01

correlated significantly with age, gender, and ethnicity. The comprehension of semantic humor was correlated significantly with ethnicity, and the comprehension of the film clips was not correlated significantly with any of the demographic variables.

Examination of these same intercorrelations in the cross-validation sample are presented in Table 12 and revealed findings generally consistent with the study sample. As with the study sample, the affective ratings of each type of humor were significantly correlated as were the comprehension scores with the exception of nonverbal humor comprehension and phonological humor comprehension. The affective ratings and comprehension scores of nonverbal humor were significantly related; however, this was not the case for the affective ratings and comprehension scores of semantic and phonological humor.

When the two samples were combined, age was no longer correlated with any of the humor variables (see Table 13). Ethnicity continued to be related to the comprehension of both types of verbal humor. The affective ratings of each type of humor were significantly correlated as were the comprehension scores. The affective ratings and comprehension scores within nonverbal and phonological humor were not significantly related; however, they were weakly related for semantic humor.

Part II: Cognitive Profiles and Humor

Verbal and Nonverbal Humor

The cognitive abilities expected to be predictive of humor comprehension include cognitive flexibility, inhibition, concept formation, working memory, and abstract reasoning; therefore, D-KEFS Trails Number-Letter Switching vs. Combined Number

Table 12
Intercorrelations Among Demographic and Humor Variables for the Cross Validation Sample

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Age	1.00													
2. Gender	.10	1.00												
3. Ethnicity	.27*	.04	1.00											
4. Handedness	-.08	-.08	-.07	1.00										
5. Total Humor Appreciation	.02	.16	-.18	.15	1.00									
6. Total Humor Comprehension	-.37**	-.12	-.30**	-.01	.19	1.00								
7. Nonverbal Appreciation	-.05	.14	-.21	.18	.85**	.26**	1.00							
8. Nonverbal Comprehension	-.18	-.07	-.11	-.19	.10	.47**	.28*	1.00						
9. Verbal Appreciation	.05	.15	-.14	.11	.95**	.13	.64**	-.01	1.00					
10. Verbal Comprehension	-.36**	-.11	-.30**	.03	.18	.97**	.20	.25*	.14	1.00				
11. Semantic Appreciation	.06	.11	-.18	.09	.94**	.18	.69**	.09	.95**	.18	1.00			
12. Semantic Comprehension	-.27*	-.15	-.25*	.01	.10	.82**	.07	.27*	.10	.82**	.16	1.00		
13. Phonological Appreciation	.05	.16	-.10	.12	.91**	.09	.58**	-.08	.98**	.12	.88**	.07	1.00	
14. Phonological Comprehension	-.35**	-.09	-.28*	.04	.20	.93**	.24*	.21	.14	.97**	.16	.65**	.13	1.00

*$p<.05$; $p<.01$

Table 13

Intercorrelations Among Demographic and Humor Variables for the Combined Study Sample and Cross Validation Sample

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Age	1.00													
2. Gender	-.13	1.00												
3. Ethnicity	.07	.07	1.00											
4. Handedness	-.04	-.05	-.02	1.00										
5. Total Humor Appreciation	.04	.03	-.08	.09	1.00									
6. Total Humor Comprehension	-.03	-.13	-.37**	-.05	.13	1.00								
7. Nonverbal Appreciation	.01	-.03	-.09	.13	.82**	.11	1.00							
8. Nonverbal Comprehension	-.03	-.09	-.14	-.11	.10	.57**	.14	1.00						
9. Verbal Appreciation	.05	.06	-.07	.06	.95**	.12	.60**	.06	1.00					
10. Verbal Comprehension	-..03	-.13	-.37**	-.02	.12	.97**	.08	.37**	.12	1.00				
11. Semantic Appreciation	.05	.04	-.06	.04	.93**	.13	.63**	.10	.95**	.11	1.00			
12. Semantic Comprehension	-.08	-.03	-.30**	-.03	.13	.76**	.06	.34**	.15	.77**	.17*	1.00		
13. Phonological Appreciation	.04	.08	-.07	.07	.92*	.11	.55**	.03	.98**	.11	.88**	.13	1.00	
14. Phonological Comprehension	-.01	-.15	-.36**	-.01	.10	.94**	.08	.33**	.09	.97**	.08	.58**	.10	1.00

*p<.05; p<.01

Sequencing and Letter Sequencing, D-KEFS Color Word Interference Inhibition vs. Color Naming, D-KEFS Free Sorting Description, WMS-3 Digit Span, WMS-3 Spatial Span, WAIS-3 Similarities, and WJ-3 Spatial Relations were selected as predictor variables. Correlations between predictor variables and humor comprehension variables are presented in Table 14. Because age, gender and ethnicity were significantly correlated with multiple outcome variables from the humor inventory as well as with a subset of cognitive predictors, they were entered as a block in the first step in all regression analyses as covariates. Supplementary analyses were performed in which demographic variables were entered as a block in the final step of the regressions as opposed to the first step to determine if the demographic variables would account for additional variance above and beyond that accounted for by the cognitive variables. These analyses yielded results that were fully consistent with those performed with demographic variables entered in the first step of the regressions. Therefore, the reported results are based on those analyses in which demographic variables were entered as a block in the first step of the regressions.

Table 14
Correlations between Predictor Variables and Humor Comprehension Variables

Variable	Verbal Humor	Nonverbal Humor	Semantic Humor	Phonological Humor
Trails Switching	.09	.14	.09	.08
Color Word Inhibition	.11	.07	.17	.08
Sorting Description	.09	.01	.04	.10
Digit Span	.25*	-.02	.20	.23*
Spatial Span	.21*	.08		
Similarities	.30*	.26*	.26*	.29**
Spatial Relations	.30*	.23*		

*p<.05; **p<.01

Prediction of Verbal Humor Comprehension

Hierarchical regression analysis was performed with verbal humor comprehension as the outcome. Variables were entered in four steps. Demographic variables were entered into the equation first. Variables expected to be predictive of only verbal humor were entered next, variables expected to be predictive of both verbal and nonverbal humor were entered in the third step, and variables that were not expected to be predictive of verbal humor were entered in the final step. The results of the hierarchical regression are presented in Table 15. The R^2 for the model was significant accounting for 35.2% of the variance. Ethnicity accounted for a significant portion of the variance in verbal humor comprehension. Caucasians had higher verbal humor comprehension scores than non-Caucasians. Measures of auditory working memory, verbal reasoning, cognitive flexibility, inhibition, and concept formation did not contribute significantly to the prediction model. As expected, the measures of visual working memory and visual-spatial reasoning did not contribute significantly to the prediction model.

Table 15
Hierarchical Regression Analysis of Verbal Humor Comprehension

	Variable	B	SE(B)	β	Sig.	95% CI for B	
						Lower	Upper
Step 1							
	Constant	30.91	4.95		.00	21.08	40.74
	Gender	-0.69	1.35	-.05	.61	-3.37	1.98
	Ethnicity	-5.86	1.26	-.43	.00	-8.37	-3.35
	Age	0.31	0.17	.18	.07	-0.03	0.65
Step 2							
	Constant	18.03	6.68		.01	4.76	31.30
	Gender	-0.40	1.31	-.03	.76	-3.02	2.21
	Ethnicity	-5.05	1.26	-.37	.00	-7.55	-2.55
	Age	0.24	0.17	.14	.16	-0.09	0.58
	Digit Span	0.27	0.16	.16	.09	-0.04	0.59
	Similarities	0.35	0.16	.21	.03	0.04	0.67
Step 3							
	Constant	10.96	8.93		.22	-6.78	28.71
	Gender	-0.41	1.35	-.03	.76	-3.10	2.28
	Ethnicity	-4.87	1.29	-.36	.00	-7.43	-2.31
	Age	0.26	0.17	.15	.14	-0.09	0.61
	Digit Span	0.28	0.17	.16	.10	-0.05	0.60
	Similarities	0.35	0.16	.21	.03	0.03	0.67
	Trails Switching	0.00	0.35	.00	.99	-0.71	0.71
	Color Word Inhibition	0.26	0.36	.07	.48	-0.47	0.98
	Sorting Description	0.10	0.09	.10	.28	-0.09	0.29
Step 4							
	Constant	-7.03	12.28		.57	-31.45	17.38
	Gender	0.07	1.37	.01	.96	-2.67	2.80
	Ethnicity	-4.64	1.27	-.34	.00	-7.18	-2.10
	Age	0.31	0.17	.18	.08	-0.03	0.66
	Digit Span	0.23	0.16	.13	.17	-1.00	0.55
	Similarities	0.27	0.16	.16	.10	-0.06	0.59
	Trails Switching	0.02	0.35	.01	.95	-0.68	0.72
	Color Word Inhibition	0.24	0.36	.06	.50	-0.48	0.97
	Sorting Description	0.04	0.10	.04	.66	-0.15	0.24
	Spatial Span	0.20	0.22	.09	.36	-0.24	0.65
	Spatial Relations	0.24	0.14	.17	.09	-0.04	0.52

Note. R^2 = .24** for Step 1; ΔR^2 = .07** for Step 2; ΔR^2 = .01 for Step 3; ΔR^2 = .04 for Step 4. *p<.05, **p<.01

Prediction of Nonverbal Humor Comprehension

Hierarchical regression analysis was performed with nonverbal humor comprehension as the outcome. Demographic variables were entered into the equation first. Variables expected to be predictive of only nonverbal humor were entered next, variables expected to be predictive of both verbal and nonverbal humor were entered in the third step, and variables that were not expected to be predictive of nonverbal humor were entered in the final step. The results of the hierarchical regression are presented in Table 16. Results indicate that the predictors do not reliably predict nonverbal humor comprehension.

Table 16
Hierarchical Regression Analysis of Nonverbal Humor Comprehension

	Variable	B	SE(B)	β	Sig.	95% CI for B	
						Lower	Upper
Step 1							
	Constant	15.38	1.58		.00	12.23	18.53
	Gender	-0.31	0.43	-.08	.47	-1.17	0.55
	Ethnicity	-0.58	0.40	-.15	.16	-1.38	0.23
	Age	-0.02	0.05	.04	.74	-0.09	0.13
Step 2							
	Constant	8.89	3.64		.02	1.66	16.11
	Gender	-0.24	0.44	-.06	.59	-1.12	0.64
	Ethnicity	-0.45	0.40	-.12	.27	-1.26	0.36
	Age	0.03	0.05	.05	.62	-0.08	0.13
	Spatial Span	-0.01	0.07	-.01	.95	-0.15	0.14
	Spatial Relations	0.09	0.04	.21	.06	-0.01	0.17
Step 3							
	Constant	7.45	3.99		.06	-0.48	15.38
	Gender	-0.34	0.45	-.09	.45	-1.24	0.55
	Ethnicity	-0.40	0.41	-.10	.34	-1.22	0.42
	Age	0.01	0.05	.02	.84	-0.10	0.12
	Spatial Span	-0.01	0.07	-.01	.93	-0.15	0.14
	Spatial Relations	0.09	0.05	.23	.05	-0.01	0.18
	Trails Switching	0.13	0.11	.13	.23	-0.09	0.36
	Color word Inhibition	0.08	0.12	.07	.49	-0.16	0.32
	Sorting description	-0.01	0.03	-.05	.66	-0.08	0.05
Step 4							
	Constant	7.97	4.01		.05	-0.01	15.94
	Gender	-0.44	0.45	-.11	.33	-1.34	0.45
	Ethnicity	-0.40	0.42	-.10	.34	-1.23	0.43
	Age	-0.02	0.06	-.04	.70	-0.13	0.09
	Spatial Span	-0.01	0.07	-.01	.95	-0.15	0.14
	Spatial Relations	0.08	0.05	.19	.09	-0.01	0.17
	Trails Switching	0.14	0.11	.13	.22	-0.09	0.37
	Color Word Inhibition	0.11	0.12	.10	.37	-0.13	0.34
	Sorting Description	-0.02	0.03	-.06	.58	-0.08	0.05
	Digit Span	-0.06	0.05	-.12	.27	-0.17	0.05
	Similarities	0.10	0.05	.20	.07	-0.01	0.20

Note. $R^2 = .03$ for Step 1; $\Delta R^2 = .04$ for Step 2; $\Delta R^2 = .02$ for Step 3; $\Delta R^2 = .05$ for Step 4.

Semantic and Phonological Verbal Humor

The cognitive abilities expected to be predictive of verbal humor include auditory working memory, inhibition, cognitive flexibility, concept formation, and verbal reasoning, with concept formation and verbal reasoning differentiating semantic and phonological humor comprehension. WMS-3 Digit Span, D-KEFS Color Word Interference Inhibition vs. Color Naming, D-KEFS Trails Number-Letter Switching vs. Combined Number Sequencing and Letter Sequencing, D-KEFS Free Sorting Description, and WAIS-3 Similarities were selected as predictor variables. Correlations between predictor variables and semantic and phonological humor comprehension are presented in Table 14.

Prediction of Semantic Verbal Humor Comprehension

Hierarchical regression analysis was performed with semantic humor comprehension as the outcome. Demographic variables were entered into the equation first. Variables expected to be predictive of only semantic humor were entered second, and variables expected to be predictive of both semantic and phonological humor were entered last. The results of the hierarchical regression are presented in Table 17. The R^2 for the model was significant accounting for 22.5% of the variance. Ethnicity and a measure of verbal reasoning accounted for a significant portion of the variance in semantic humor comprehension. Caucasians had higher comprehension scores than non-Caucasians, and higher performance on a measure of verbal reasoning was related to

higher semantic humor comprehension scores. Measures of concept formation, cognitive flexibility, inhibition, and auditory working memory, did not contribute significantly to the prediction model.

Table 17
Hierarchical Regression Analysis of Semantic Verbal Humor Comprehension

	Variable	B	SE(B)	β	Sig.	95% CI for B	
						Lower	Upper
Step 1							
	Constant	11.69	1.50		.00	8.70	14.67
	Gender	0.67	0.41	.17	.10	-0.14	1.49
	Ethnicity	-1.37	0.38	-.35	.00	-2.14	-0.61
	Age	-.05	0.05	.10	.31	-0.05	0.15
Step 2							
	Constant	9.45	2.12		.00	5.23	13.67
	Gender	0.67	0.40	.17	.10	-0.13	1.47
	Ethnicity	-1.27	0.38	-.32	.00	-2.03	-0.50
	Age	0.03	0.05	.06	.58	-0.08	0.13
	Sorting Description	0.01	0.03	.03	.75	-0.05	0.07
	Similarities	0.10	0.05	.20	.04	0.01	0.20
Step 3							
	Constant	6.07	2.73		.03	0.65	11.49
	Gender	0.72	0.41	.18	.08	-0.10	1.54
	Ethnicity	-1.07	0.39	-.27	.01	-1.85	-0.29
	Age	0.03	0.05	.06	.55	-0.07	0.14
	Sorting Description	0.02	0.03	.05	.62	-0.04	0.07
	Similarities	0.10	0.05	.21	.04	0.01	0.20
	Trails Switching	-0.01	0.11	-.01	.92	-0.23	0.21
	Color Word Inhibition	0.14	0.11	.12	.22	-0.08	0.36
	Digit Span	0.08	0.05	.16	.13	-0.02	0.18

Note. R^2 = .15** for Step 1; ΔR^2 = .04 for Step 2; ΔR^2 = .04 for Step 3.
*p<.05, **p<.01

Prediction of Phonological Verbal Humor Comprehension

Hierarchical regression analysis was performed with phonological humor comprehension as the outcome. Demographic variables were entered into the equation first. Variables expected to differentiate between semantic and phonological humor were entered second, and variables expected to be predictive of both semantic and

phonological humor were entered last. The results of the hierarchical regression are presented in Table 18. The R^2 for the model was significant accounting for 30.3% of the variance. Ethnicity reliably contributed to the prediction model. Caucasians had higher phonological humor comprehension scores than non-Caucasians. As with semantic humor comprehension, measures of concept formation, cognitive flexibility, inhibition, and auditory working memory, did not contribute significantly to the prediction model. Contrary to semantic humor comprehension, the measure of verbal reasoning did not contribute significantly to the prediction of phonological humor comprehension.

Table 18
Hierarchical Regression Analysis of Phonological Verbal Humor Comprehension

	Variable	B	SE(B)	β	Sig.	95% CI for B	
						Lower	Upper
Step 1							
	Constant	19.42	4.03		.00	11.42	27.43
	Gender	-1.39	1.10	-.12	.21	-3.57	0.78
	Ethnicity	-4.55	1.03	-.41	.00	-6.59	-2.50
	Age	0.26	0.14	.18	.07	-0.02	-0.53
Step 2							
	Constant	11.39	5.67		.05	0.12	22.67
	Gender	-1.34	1.08	-.12	.22	-3.49	0.80
	Ethnicity	-4.25	1.02	-.38	.00	-6.28	-2.22
	Age	0.21	0.14	.15	.14	-0.07	0.49
	Sorting Description	0.08	0.08	.09	.32	-0.08	0.23
	Similarities	0.25	0.13	.18	.06	-0.01	0.51
Step 3							
	Constant	5.06	7.35		.49	-9.56	19.67
	Gender	-1.17	1.11	-.10	.30	-3.38	1.05
	Ethnicity	-3.86	1.06	-.35	.00	-5.96	-1.75
	Age	0.22	0.14	.15	.12	-0.06	0.51
	Sorting Description	0.09	0.08	.10	.28	-0.07	0.24
	Similarities	0.25	0.13	.18	.06	-0.01	0.52
	Trails Switching	0.01	0.29	.01	.97	-0.57	0.59
	Color Word Inhibition	0.13	0.30	.04	.66	-0.47	0.73
	Digit Span	0.20	0.14	.14	.15	-0.07	0.47

Note. R^2 = .24** for Step 1; ΔR^2 = .04* for Step 2; ΔR^2 = .02 for Step 3.
*p<.05, **p<.01

Part III: Humor Appreciation and the Ventromedial Prefrontal Cortex

VMPFC functioning and its interaction with humor comprehension were expected to be predictive of humor appreciation; therefore, two indicators of VMPFC function, the IGT and ToM cartoons, were selected as predictor variables. Correlations among the predictor variables are presented in Table 19. Age and ethnicity were significantly correlated with both predictor and outcome variables and were entered first in the regression analyses as covariates.

Table 19
Intercorrelations Among Possible Predictors and Humor Appreciation

	1	2	3	4
Total Humor Comprehension	1.00			
Iowa Gambling Task	.17	1.00		
Theory of Mind Cartoons	.17	-.10	1.00	
Total Humor Appreciation	.04	-.08	-.06	1.00

Humor Appreciation and the Iowa Gambling Task

Hierarchical regression analysis was conducted to explore the contribution of the VMPFC, as measured by the IGT, in interaction with humor comprehension to humor appreciation. Variables were entered in four steps. Demographic variables were entered in the first step, humor comprehension was entered in the second step, the indicator of VMPFC functioning (i.e., the IGT) was entered in the third step, and the interaction term between humor comprehension and the indicator of VMPFC functioning was entered in the fourth step. As shown in Table 20, the predictors do not reliably predict humor appreciation.

Table 20
Hierarchical Regression Analysis of Humor Comprehension and the Ventromedial Prefrontal Cortex Function as Measured by the Iowa Gambling Task

	Variable	B	SE(B)	β	Sig.	95% CI for B	
						Lower	Upper
Step 1							
	Constant	162.18	36.58		.00	89.52	234.85
	Ethnicity	1.40	11.68	.01	.90	-21.80	24.61
	Age	0.77	1.50	.05	.61	-2.22	3.76
Step 2							
	Constant	147.32	52.69		.01	42.64	252.00
	Ethnicity	3.56	12.95	.03	.78	-22.17	29.29
	Age	0.65	1.54	.05	.65	-2.42	3.71
	Humor Comprehension	0.34	0.86	.05	.70	-1.36	2.04
Step 3							
	Constant	153.60	53.29		.01	47.71	259.49
	Ethnicity	0.23	13.56	.00	.99	-26.71	27.16
	Age	0.65	1.54	.05	.67	-2.42	3.72
	Humor Comprehension	0.36	0.86	.05	.67	-1.34	2.07
	Iowa Gambling Task	-0.18	0.21	-.10	.40	-0.59	0.24
Step 4							
	Constant	168.88	54.20		.00	61.17	276.59
	Ethnicity	0.21	13.49	.00	.99	-26.60	27.02
	Age	0.77	1.54	.05	.62	-2.29	3.83
	Humor Comprehension	-0.08	0.91	-.01	.93	-1.89	1.74
	Iowa Gambling Task	-2.01	1.36	-1.08	.14	-4.71	0.69
	Interaction Between Humor Comprehension and IGT	-.04	0.03	1.01	.17	-0.02	1.03

Note. R^2 = .003 for Step 1; ΔR^2 = .002 for Step 2; ΔR^2 = .01 for Step 3; ΔR^2 =.02 for Step 4.

A median split was used to divide performance on the IGT into high and low performance groups. The low performance groups consisted of those participants whose scores on the IGT were equal to or below the median. The high performance group consisted of those participants with IGT scores above the median. Forty-eight participants were in the low performance group, and forty-six participants were in the high performance group. Variables were entered in four steps. Demographic variables were entered in the first step, humor comprehension was entered in the second step, the indicator of VMPFC functioning (i.e., IGT) was entered in the third step, and the

interaction term between humor comprehension and the indicator of VMPFC functioning was entered in the fourth step. The results of the hierarchical regression are presented in Table 21. The results indicate that the predictors do not reliably predict humor appreciation. The results did not change when verbal and nonverbal appreciation were analyzed separately.

Table 21
Hierarchical Regression Analysis of Humor Comprehension and the Ventromedial Prefrontal Cortex Function as Measured by the Iowa Gambling Task

	Variable	B	SE(B)	β	Sig.	95% CI for B	
						Lower	Upper
Step 1							
	Constant	162.18	36.58		.00	89.52	234.85
	Ethnicity	1.40	11.68	.01	.90	-21.80	24.61
	Age	0.77	1.50	.05	.61	-2.22	3.76
Step 2							
	Constant	147.32	52.69		.01	42.64	252.00
	Ethnicity	3.56	12.95	.03	.78	-22.17	29.29
	Age	0.65	1.54	.05	.65	-2.42	3.71
	Humor Comprehension	0.34	0.86	.05	.70	-1.36	2.04
Step 3							
	Constant	147.75	53.81		.01	40.83	254.67
	Ethnicity	3.37	13.64	.03	.80	-23.73	30.48
	Age	0.65	1.55	.05	.68	-2.44	3.73
	Humor Comprehension	0.34	0.86	.05	.69	-1.38	2.06
	Iowa Gambling Task	-0.58	12.70	-.01	.96	-25.81	24.64
Step 4							
	Constant	144.70	53.91		.01	37.57	251.84
	Ethnicity	2.29	13.69	.02	.87	-24.91	29.49
	Age	0.70	1.55	.05	.65	-2.38	3.79
	Humor Comprehension	0.35	0.86	.05	.68	-1.36	2.07
	Iowa Gambling Task	15.95	21.10	.14	.45	-25.99	57.88
	Interaction Between Humor Comprehension and IGT	-.01	.01	-.19	.33	-0.02	.01

Note. R^2 = .003 for Step 1; ΔR^2 = .002 for Step 2; ΔR^2 = .00 for Step 3; ΔR^2 =.01 for Step 4.

Humor Appreciation and Theory of Mind Cartoons

Hierarchical regression analysis was conducted to explore the contribution of the VMPFC, as measured by ToM cartoons, in interaction with humor comprehension to humor appreciation. Demographic variables were entered in the first step, humor comprehension was entered in the second step, the indicator of VMPFC functioning (i.e., ToM cartoon task) was entered in the third step, and the interaction term between humor comprehension and the indicator of VMPFC functioning was entered in the fourth step. As shown in Table 22, the predictors do not reliably predict humor appreciation. The results did not change when verbal and nonverbal appreciation were analyzed separately.

Table 22
Hierarchical Regression Analysis of Humor Comprehension and the Ventromedial Prefrontal Cortex Function as Measured by Theory of Mind Cartoons

	Variable	B	SE(B)	β	Sig.	95% CI for B	
						Lower	Upper
Step 1							
	Constant	162.18	36.58		.00	89.52	24.85
	Ethnicity	1.40	11.68	.01	.90	-21.80	24.61
	Age	0.77	1.50	.05	.61	-2.22	3.76
Step 2							
	Constant	147.32	52.69		.01	42.64	252.00
	Ethnicity	3.56	12.95	.03	.78	-22.17	29.29
	Age	0.65	1.54	.05	.67	-2.42	3.71
	Humor Comprehension	0.34	0.85	.05	.69	-1.36	2.03
Step 3							
	Constant	165.94	57.99		.01	50.71	281.16
	Ethnicity	5.75	13.28	.05	.67	-20.65	32.14
	Age	0.70	1.55	.05	.65	-2.38	3.77
	Humor Comprehension	0.48	0.87	.07	.59	-1.26	2.21
	ToM Cartoon Task	-0.96	1.23	-.09	.44	-3.40	1.49
Step 4							
	Constant	304.03	242.36		.21	-177.61	785.67
	Ethnicity	5.92	13.33	.05	.66	-20.59	32.42
	Age	0.68	1.55	.05	.66	-2.41	3.76
	Humor Comprehension	-2.79	5.63	-.39	.62	-13.98	8.40
	ToM Cartoon Task	-5.55	7.93	-.49	.49	-21.31	10.21
	Interaction Between Humor Comprehension and ToM	0.11	0.18	.65	.56	-0.26	0.48

Note. $R^2 = .003$ for Step 1; $\Delta R^2 = .002$ for Step 2; $\Delta R^2 = .01$ for Step 3; $\Delta R^2 = .004$ for Step 4.

CHAPTER 5

DISCUSSION

The present study investigated humor perception in neurologically healthy adults. Previous research has indicated that deficits in particular cognitive processes accompany impaired humor comprehension in brain injured individuals. Less is known about humor appreciation, its relation to humor comprehension, and the types of cognitive processes that may be related to it. The goal of this study was to investigate the cognitive processes that underlie humor comprehension and appreciation in a sample of undergraduate college students. First, the relations between verbal and nonverbal humor and specific cognitive processes were investigated. Given that different types of verbal humor have been associated with different neural networks, two kinds of verbal humor, semantic and phonological, were explored. Second, this study investigated the relationship between humor comprehension and humor appreciation and the role of VMPFC functioning.

Neuropsychological Profiles and Humor Comprehension

Cognitive processing deficits in working memory, verbal and visual-spatial reasoning, cognitive flexibility, and concept formation are related to humor comprehension in brain injured individuals (Bihrl, Brownell, Powelson, & Gardner, 1986, Brownell, Michel, Powelson, & Gardner, 1983; Dagge & Hartje, 1985, Shammi & Stuss, 1999). Detection/resolution of incongruity also is considered an important component of humor comprehension (Dixon, 1980; Fry, 2002; Morreall, 1989; Paulos, 1980; Raskin, 1985; Ruch, McGhee, & Hehl, 1990). Therefore, a measure of response

inhibition that incorporates these component skills was included as a potential predictor of humor comprehension in neurologically healthy individuals.

Verbal Humor Comprehension

It was predicted that measures of auditory working memory, verbal reasoning, cognitive flexibility, response inhibition, and concept formation would be predictive of verbal humor. Contrary to expectation, none of the measures of cognitive abilities predicted comprehension of verbal humor.

Using event-related fMRI, Goel and Dolan (2001) found that separate networks were activated for semantic and phonological jokes. Research has demonstrated that individuals with autism and Asperger syndrome understand basic forms of humor that do not require inferences, such as puns (Emerich, Creaghead, Grether, Murray, & Grasha, 2003; Reddy, Williams, & Vaughan, 2002; St. James & Tager-Flusberg, 1994; Van Bourgondien & Mesibov, 1987). These studies suggest that there may be differences in the cognitive abilities required for the comprehension of humor that does not require inferences (e.g., phonological jokes) and for humor that does (e.g., semantic jokes). Given the evidence that different types of verbal humor are associated with different neural networks, two kinds of verbal humor, semantic and phonological, were explored.

Semantic Humor Comprehension

The expected differences between the comprehension of semantic and phonological verbal humor were not fully supported. Measures of concept formation, verbal reasoning, cognitive flexibility, inhibition, and auditory working memory were expected to be predictive of semantic humor comprehension; however, only the measure

of verbal reasoning contributed significantly to the model. The relationship between verbal reasoning and semantic humor suggests a contribution for verbal reasoning in the comprehension of verbal humor in which the humor is a function of factors other than simple word play.

Phonological Humor Comprehension

It was expected that measures of cognitive flexibility, inhibition, and auditory working memory would be predictive of phonological humor comprehension; however, none of the measures of cognitive abilities contributed significantly to the model.

Nonverbal Humor Comprehension

Nonverbal humor comprehension may require different underlying cognitive abilities than verbal humor comprehension. It was expected that visual working memory, visual-spatial reasoning, cognitive flexibility, inhibition, and concept formation would be predictive of nonverbal humor. Contrary to expectation, none of the measures of cognitive abilities used in the present study predicted comprehension of nonverbal humor.

Limitations

Limitations related to the model on which the hypotheses are based and the measures of cognitive abilities used in this study must be taken into account when interpreting the findings. In this investigation of humor perception among neurologically healthy individuals, the hypotheses were based on studies of humor perception among individuals with brain injuries. It is possible that there are differences in the relations between cognitive functions and humor comprehension for individuals with and without

brain injury that would account for the study's failure to support the hypotheses. Humor perception may require a baseline level of cognitive abilities, but beyond this baseline, the cognitive abilities may not be systematically contributory. When cognitive abilities are intact at or above a certain level, other variables (e.g., personality factors, mood) may become more important.

The measures used were generally developed to detect or describe aspects of brain injury. They were not designed to closely examine variations in a normal sample. There was limited variance in performance on some measures of cognitive abilities in this sample. On the measures of inhibition, concept formation, and verbal reasoning, the proportion of scores that fell between the 25th and 75th percentiles based on normative data were 89.4%, 79.8%, and 77.7% respectively. 76.6% of the scores on both the measure of cognitive flexibility and the measure of visual working memory fell between the 25th and 75th percentiles. This restricted range could account for the study's failure to support the hypotheses.

The absence of expected relationships among measures of executive function suggests that the study sample's performance differed from standardization samples used to norm the measures of executive cognitive function administered in this study. The reported correlation between the measures of auditory working memory and verbal reasoning is .38 with individuals 20 to 24 years old in the standardization sample (Wechsler, 1997), but the correlation between those measures is .04 in the study sample. The reported correlation between the measures of auditory working memory and visual working memory equals .42 with individuals 16 to 29 years old in the standardization

sample (Wechsler, 1997), but it is .18 in the study sample. The reported correlations between measures of concept formation and inhibition and between measures of concept formation and cognitive flexibility are .18 and .32 respectively among individuals 20 to 49 years old in the standardization sample (Delis, Kaplan, & Kramer, 2001); however, those correlations equal -.04 and .17 respectively in the study sample. Lastly, the reported correlation between measures of inhibition and cognitive flexibility is .33 among individuals 20 to 49 years old in the standardization sample (Delis, Kaplan, & Kramer, 2001) and .40 in the study sample. Although these differences may suggest the possibility of problems with consistent motivation and/or effort, the study sample's demographic characteristics also should be considered when interpreting this finding. For example, there was a larger proportion of non-Caucasian participants in this sample than in standardization samples. On the other hand, several studies have found relatively low intercorrelations among tests of executive function (Duncan et al., 1997; Humes et al., 1997; Miyake et al., 2000; Welsh et al., 1999). Thus, the limited relations among measures of executive function may simply reflect the measurement of multiple skills.

The results of this investigation of humor comprehension and cognitive abilities may differ from previous research due to the nature of the measures used to assess cognitive abilities. With one exception, the cognitive measures used in the present study were chosen to assess the cognitive abilities previously shown to be related to humor comprehension in brain injured individuals. However, many of the specific measures chosen for the present study differed from those used in previous studies. Therefore, this is the first study to use the particular combination of measures implemented. In addition,

previous research has not investigated the relationship between humor comprehension and detection/resolution of incongruity; therefore, the present study included a measure of response inhibition that incorporates these abilities.

In the present study, the measure of visual working memory required visual tracking and the mental manipulation of information, but did not require visual search abilities and perceptual discrimination, in contrast to the measure employed by Shammi and Stuss (1999). Thus, it was considered a purer measure of visual working memory. Although both tracking and visual search tasks require vigilance and the selection of some spatially localized items, it is possible that they are measuring different subsystems of working memory, and it is visual search and/or perceptual discrimination that are critical to nonverbal humor comprehension rather than visual working memory.

Dagge and Hartje (1985) concluded that the impaired humor perception of individuals with right hemisphere brain damage was due to difficulties with visual-spatial reasoning as evidenced by their descriptions of cartoons. Cartoon descriptions are not purely perceptual in nature. They place an emphasis on expressive language, whereas the measure of visual-spatial reasoning used in the present study did not. The expressive language demands may have confounded the task and resulted in performance that was not solely reflective of visual-spatial reasoning. This raises the possibility that visual-spatial reasoning is not important for nonverbal humor comprehension. It also is possible that there are differences in visual–spatial reasoning depending on the stimulus. That is, visual-spatial reasoning for manipulation of geometric figures, as used in the current study, may differ from reasoning about social situations, as in cartoons.

Previous research has used cartoon completion tasks and descriptions of neutral and humorous cartoons as indicators of concept formation (Bihrl, Brownell, Powelson, & Gardner, 1986; Brownell, Michel, Powelson, & Gardner, 1983; Gillikin & Derks, 1991). In this study, a measure of concept formation and problem solving was used. This measure of concept formation did not require the ability to understand a sequence as is necessary for cartoon completion tasks. In addition, it did not place a heavy emphasis on expressive linguistic ability as do cartoon descriptions. It is possible that the cartoon descriptions were confounded by expressive language demands and were not good measures of concept formation. In that case, the conclusion that concept formation is important in humor perception may not be accurate. Instead, sequential processing may be critical for humor perception.

Incongruity is an important characteristic of humor (McGhee, 1979; Morreall, 1989; Raskin, 1985; Ruch, McGhee, & Hehl, 1990). In a review of research studies of laughter in children, Rothbart (1973) posited that it is simply the presence of an incongruity rather than the resolution of incongruity that leads to humor. Inhibition tasks are confounded with both the detection of the incongruity and its resolution. If Rothbart's theory is accurate, a measure of the response to incongruity (e.g., physiological arousal when faced with an incongruent stimulus) may be more predictive of humor than a measure of response inhibition.

Humor Appreciation and the Ventromedial Prefrontal Cortex

Humor perception involves both humor comprehension and appreciation. It has been suggested that the appreciation of humor requires the integration of cognitive and

affective information. There is increasing support for the hypothesis that the VMPFC mediates processes of integration between cognition and affective states. Because the VMPFC appears to have a role in attaching emotional valence to stimuli (Elliott, Dolan, & Frith, 2000; Kawasaki et al., 2001), it was expected that the integrity of this area would influence humor appreciation. Two indicators of VMPFC functioning, the IGT and ToM Cartoons, were used in this study. It was predicted that performances on the IGT and the ToM cartoon task would moderate the relationship between humor comprehension and affective ratings. That is, the predictive relationship between comprehension scores and affective ratings would increase as a function of increased performances on the IGT and ToM cartoon task.

The present study failed to support the hypothesis concerning the role of the VMPFC in humor appreciation. Neither humor comprehension nor VMPFC functioning predicted humor appreciation when the IGT or a ToM task were utilized as indicators of VMPFC functioning. Furthermore, the relationship between comprehension scores and affective ratings was not influenced by performances on the IGT or the ToM cartoon task.

Limitations

In the present study, it was assumed that humor comprehension is necessary but not sufficient for humor appreciation; however, the results suggest that humor comprehension is not required for the experience of humor. This suggests that the experience of humor may depend more on the appreciation of qualitative features of the humor stimulus than on its comprehension. That is, the humor response may be a

function of factors other than humor comprehension, such as paralinguistic features and physical nonverbal behaviors. The lack of relationship between humor comprehension and appreciation also may be the result of factors that are unrelated to the humor stimuli, such as demand characteristics or participant mood states. Lastly, the controlled environment in which the study took place could diminish the humor response.

Given that the VMPFC appears to have a role in attaching emotional valence to stimuli (Elliott, Dolan, & Frith, 2000; Kawasaki et al., 2001), it was assumed that this area would be involved in humor appreciation. It is possible that the IGT and ToM tasks simply did not adequately assess the functions of the VMPFC that are believed to be involved with humor appreciation. Measures of physiological arousal (e.g., skin conductance response and heart rate) may be more accurate indicators of this specific function of the VMPFC. The ToM task and the IGT, which are both indicators of VMPFC functioning, were not significantly correlated, which suggests that performance on these tasks is mediated by independent processes. For example, the IGT may be mediated by the process of linking complex situations and their associated somatosensory and emotional states (Damasio, 1994), whereas ToM has been associated with the process of integrating the cognitive and affective aspects of situations (Baron-Cohen et al. 1999). It also has been found that performance on the IGT varies widely among neurologically intact individuals despite their having similar physiological responses, suggesting that performance on the IGT may be independent from VMPFC functioning in some cases (Bechara, Damasio, & Damasio, 2000). As a result, performance on the IGT may not

reflect VMPFC functioning for a portion of the normal population, which would obscure the relationship between VMPFC functioning and humor appreciation.

Humor Comprehension/Appreciation Inventory: Development and Assessment of Psychometric Properties

The humor comprehension/appreciation inventory was created for the purposes of this study. Previous research primarily has utilized humor inventories, self-report, joke-stem completion tasks, and pictorial cartoon tasks to investigate humor comprehension and appreciation. The stimuli were often static, which affected their ecological validity, and performance on these types of stimuli may have been confounded by the participants' levels of metacognition. The Humor Comprehension/Appreciation Inventory was composed of dynamic humorous stimuli. Immediately following presentation of a humorous stimulus, the computer program allowed the participants to rate its funniness before eliciting their level of comprehension. Comprehension questions were presented in multiple choice format in order to eliminate potential confounds related to expressive language. Further, by presenting the comprehension questions in multiple choice format, responses could be scored objectively.

The humor comprehension/appreciation inventory was administered to an independent sample for cross-validation. Cross validation is the process of assessing the stability of patterns of performance on a cognitive or behavioral measure in an independent sample of participants from the same population. Cross validation of the humor comprehension/appreciation inventory revealed results that were very similar to the initial findings. Comparison of mean performance levels for the dependent variables

used in this study did not reveal any significant differences between these two samples. With both the study sample and the cross validation sample, the affective ratings were significantly correlated across humor types, suggesting that finding one type of humor enjoyable was related to finding the other types of humor enjoyable. Previous research has demonstrated that humor evaluations can be related to mood state (Deckers, 1998; Flugel, 1954; Ruch & Kohler, 1998), tolerance of ambiguity (Durrheim, 1998), and other personality variables such as conservatism (McGhee, Ruch, & Hehl, 1990) and need for cognition (Zhang, 1996). The relationships among the affective ratings also may reflect the influence of response bias or demand characteristics, which may result in consistency across items. With both the study sample and the cross validation sample, comprehension scores were significantly correlated across humor types with the exception of nonverbal and phonological humor comprehension in the cross validation sample. This suggests that competence with one type of humor was related to competence with other types of humor.

Some differences were identified in the pattern of correlations between the comprehension and appreciation components of the humor battery. In the study sample, the appreciation and comprehension of the different types of humor were not correlated. Appreciation and comprehension were not significantly related within the semantic and phonological humor types in the cross validation sample; however, nonverbal appreciation and comprehension were related.

In both the study sample and cross validation sample, there were differences in the participants' comprehension and affective ratings of verbal and nonverbal humor and

of semantic and phonological humor. The participants had higher comprehension scores for nonverbal humor than verbal humor. Participants also gave higher affective ratings to the nonverbal humor than the verbal humor. When verbal humor was separated into semantic and phonological types, it was found that the participants had higher comprehension scores for semantic humor than phonological humor. Participants also gave higher affective ratings to the semantic humor than the phonological humor.

It is possible that differences in the comprehension and affective ratings across different types of humor stimuli are attributable to differences in their complexity. In studies of cognitive processes and humor development in children, humor appreciation was related to the degree of cognitive challenge necessary for its comprehension (McGhee, 1976; Zigler, Levine, & Gould, 1967). In general, the authors found a hyperbolic relationship between cognitive complexity and humor appreciation. Humor that made few or advanced cognitive demands was perceived as being less funny. Given that verbal humor was associated with lower comprehension scores than nonverbal humor, it is plausible that the verbal humor required more advanced cognitive demands for its comprehension than the nonverbal humor. Phonological humor was presumed to be a more basic form of humor than semantic humor; however, in this study, phonological humor was associated with lower comprehension scores than semantic humor. These findings suggest that, in this sample, the phonological humor may have necessitated a higher degree of cognitive challenge for its comprehension than the semantic humor, which resulted in its being associated with lower comprehension scores

and affective ratings. It is possible that phonological humor was more challenging to accurately comprehend due to difficulty understanding the directness of its wit.

Limitations

The nature of the measure used to assess humor comprehension may have contributed to differences between the results of this investigation and previous research. Shammi and Stuss (1999) assessed nonverbal humor using funny/unfunny cartoon discrimination, funniness ratings, and mirth responses to static cartoons. In the present study, the nonverbal humor stimuli were dynamic, and nonverbal humor comprehension was measured by the participants' selections of the funny elements of the humorous stimuli from multiple choice options. Gestures, body movements, and changing facial expressions are present in film clips and absent from static cartoons. These nonverbal cues convey additional affective information that influences how the different elements of the situation are perceived (Rashotte, 2002). Thus, the various nonverbal cues present in the film clips may have necessitated different cognitive abilities for their comprehension than static cartoons. Likewise, the cognitive abilities required for joke comprehension may differ for oral joke performance, as in this study, and written jokes, as used by Shammi and Stuss. Written and spoken presentations of jokes differ in important ways. Paralinguistic features, such as tone of voice and pauses, can provide contextual cues which can affect the interpretation of the humor (Norrick, 2004).

Humor appreciation was indicated by a rating on an ordinal scale. Ordinal scales presume the existence of an underlying continuous variable whose value characterizes the respondents' attitudes and opinions. Because the values of the ordinal scale are

interpreted subjectively, inferential errors can occur. As previously stated, other factors that may have influenced the humor appreciation rating include personality factors and the testing environment.

There are cross-cultural differences in humor appreciation, suggesting that different types of humor are appreciated by differing groups of people (Alden, Hoyer, & Lee, 1993). In the present study, ethnicity predicted overall verbal humor comprehension, as well as both semantic and phonological humor comprehension, with. Caucasian ethnicity predictive of higher comprehension scores. This likely is due to the fact that the verbal humor stimuli were not selected with particular consideration of the likely ethnic composition of the study sample. All of the verbal humor stimuli were from *A Prairie Home Companion Pretty Good Joke Tape*, which was developed from radio joke shows originating in the Midwestern United States. Although none of the jokes made reference to ethnicity and the speakers were both male and female, all of the speakers were Caucasian.

Future Directions

The limitations of the present study present avenues for future research. First, investigators may wish to address issues concerning the humor comprehension/appreciation inventory. It would be useful to develop measures of humor perception that are more ecologically valid than those used in previous research or the current study. This may be achieved through the use of virtual reality or actual social situations.

The current study demonstrates that ethnicity may influence humor comprehension. The role of ethnicity and humor comprehension has not been explored, yet this study provides evidence that the comprehension of different types of humor differs based on ethnicity. Future research in this area should consider the contribution of ethnic differences in designing measures of humor perception.

It may be important to consider additional factors in predicting humor appreciation. Although cognitive abilities are important in humor comprehension, affective ratings of humor are subjective and thus can be affected by raters' attitudes and moods (Gardner, 1985). Other personality variables also may be important in humor appreciation. In a study using event-related fMRI to examine humor appreciation and personality, Mobbs et al. (2005) found that extroversion and emotional stability correlated with humor-driven BOLD signal in the VMPFC and introversion correlated with increased activation in the amygdala. The authors concluded that personality style plays an important role in the neurobiological systems involved in humor appreciation. Zhang (1996) suggested that individual differences in need for cognition interact with cognitive predictors to affect humor appreciation. McGhee, Ruch, and Hehl (1990) have shown that conservatism, sensation seeking, and intolerance of ambiguity have been strongly linked with enjoyment of incongruity-resolution humor as opposed to nonsense humor. Thus, future models should consider personality and mood variables as predictors of humor appreciation.

Regarding the measures of cognitive abilities, it would be useful to explore literature in cognitive psychology for measures that are sensitive to more variance in a

normal sample than the vast majority of neuropsychological tests developed for use in clinical populations.

Physiological arousal is another factor to consider when predicting humor appreciation. Studies investigating physiological arousal and humor have indicated that arousal is necessary for humor. Because somatic arousal is represented in the VMPFC (Critchley et al., 2000), measurements of physiological arousal (e.g., skin conductance response and heart rate) may be suitable indicators of the role of the VMPFC in humor appreciation.

The study sample was composed of undergraduate psychology students in a metropolitan, non-traditional university in the southeastern United States. All of the participants received course credit for their participation. It is possible that the sample recruitment strategy used did not allow for enough variance in the sample, thus precluding the ability to find differences in performance on the cognitive variables and also limiting the generalizability of the findings to the general population.

Summary

In conclusion, semantic humor comprehension is related to verbal reasoning. Failure to replicate the previously reported relationships between cognitive abilities and humor comprehension could be due to the nature of the measures used to assess the cognitive abilities hypothesized to be related to humor and/or the nature of the humor stimuli. Future research is necessary to further evaluate the relationships between cognitive abilities and humor perception using humor stimuli that has been matched for

complexity. Researchers should take into consideration the findings of McGhee (1976) and Zigler, Levine, and Gould (1967) by using humor stimuli of moderate complexity.

The IGT and ToM abilities have been used as indicators of VMPFC functioning, and there is evidence to support the notion that the VMPFC is involved in humor perception (Goel & Dolan, 2001; Iwase et al., 2002). The relationship between humor comprehension, the VMPFC, and humor appreciation was not supported in this study. This likely is due to issues related to the nature of the stimuli used to assess humor. It is also possible that the IGT and the ToM cartoon task used in this study do not tap into the specific processes of the VMPFC that are involved in humor appreciation. Further exploration of the contribution of the VMPFC to humor appreciation is needed. Future research should take into consideration the role of personality factors and physiological arousal in humor appreciation. Data should be analyzed to look for differential patterns of humor appreciation based on personality or physiological variables.

The hypothesis that certain cognitive processes would predict humor comprehension among neurologically healthy individuals was based on studies of individuals with brain damage. The finding that neurologically healthy individuals did not demonstrate the same pattern is interesting, suggesting that there may be important differences in the relations between cognitive functions and humor comprehension for neurologically healthy and brain injured individuals.

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Appendix A

Humor Inventory Rating Scales and Multiple Choice Options

Phonological Jokes

1. This man entered a pun contest and he sent in 10 different puns in hopes that one would win. Unfortunately, no pun in ten did.

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the joke?

What makes this joke funny?

a. No pun won
b. Play on the word(s):_____(fill in the blank)
c. Entering a pun contest is a funny thing to do
d. There is no such thing as a pun contest
e. Not sure

2. A cowboy walks into the bar. His hat his made of brown paper and shirt and his vest are made of wax paper. He had chaps and his pants and even his boots were made of paper. Even his spurs were made of tissue paper. Pretty soon they arrested him for rustling.

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the joke?

What makes the joke funny?

a. Play on the word(s):_____(fill in the blank)
b. His clothes were made of paper
c. He was arrested because his clothes were noisy
d. The cowboy went out in public wearing paper clothes
e. Not sure

3. A farmer's milking his cow, and as he's milking a fly comes along and flies into the cows ear and just a little bit later the farmer notices a fly in the milk. The farmer says, "hmm, in one ear and out the udder."

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the joke?

What makes the joke funny?

a. The fly traveled through the cow from its ear to its udder
b. Play on the word(s):_____(fill in the blank)
c. The fly went in one ear and out the other ear
d. The fly flew out of the cow's ear and into the milk
e. Not sure

4. A man is celebrating his 90th birthday down at the nursing home and his friends decide to surprise him. They wheel in this big birthday cake and out pops a beautiful young woman who says, "Hi, I can give you some super sex." The man says, "Well, I guess I'll take the soup."

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the joke?

What makes the joke funny?

a. The man misunderstands the question
b. A surprise party was thrown for a man who was 90
c. The man spoke funny
d. Play on the word(s):_____(fill in the blank)
e. Not sure

5. What do you call a deer with no eyes?
No eye deer.

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you “get” the joke?

What makes the joke funny?

a. A deer with no eyes
b. Play on the word(s):_____(fill in the blank)
c. No-eye deer is a funny name for a deer with no eyes
d. A deer with no eyes would be unable to see
e. Not sure

6. Did you hear about the skunk who went to church?
He had his own pew.

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you “get” the joke?

What makes the joke funny?

a. The skunk had a pew all to himself
b. The skunk was stinky
c. Play on the word(s):_____(fill in the blank)
d. Skunks do not go to church
e. Not sure

7. Why couldn't the pony talk?
He was a little hoarse.

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the joke?

What makes the joke funny?

a. A pony is a small horse
b. Play on the word(s):_____(fill in the blank)
c. Small horses can't talk
d. Pony's can never talk
e. Not sure

8. Did you hear about the 2 silkworms that were in a race?
They wound up in a tie.

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the joke?

What makes the joke funny?

a. Play on the word(s):_____(fill in the blank)
b. The worms were equally slow
c. Dual meaning of the word silk
d. Some ties are made of silk
e. Not sure

9. *Man:* Doctor, you've got to help me. Some mornings I wake up and think I'm Donald Duck. Other mornings, I think I'm Mickey Mouse.

Doctor: Hmm, how long have you been having these Disney spells?

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you “get” the joke?

What makes the joke funny?

a. Play on the words Donald Duck
b. The man is having spells of Disney characters
c. The man thinks he is a cartoon character
d. Play on the word(s):_____(fill in the blank)
e. Not sure

10. Why did the scientist install a knocker on his door?
To win the Nobel Prize.

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you “get” the joke?

What makes the joke funny?

a. The scientist thought this was a prize-winning idea
b. A knocker on the door would distract the scientist from his work less than a doorbell
c. Prizes are given out to people who do not have door bells
d. Play on the word(s):_____(fill in the blank)
e. Not sure

11. What do you call cheese that doesn’t belong to you?
Nacho cheese.

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you “get” the joke?

What makes the joke funny?

a. The second speaker misunderstands the first speaker
b. Not-your-cheese is a good name for cheese that isn’t yours
c. Play on the word(s):_____(fill in the blank)
d. The dual meaning of cheese
e. Not sure

12. A guy walks into a bar with a giraffe.
Guy: A beer for me and one for my giraffe.
They stand around drinking for hours until the giraffe passes out on the floor. The guy pays the tab and gets up to leave.
Bartender: Hey, you’re not going to leave that lying on the floor are you?
Guy: That’s not a lion, it’s a giraffe.

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you “get” the joke?

What makes the joke funny?

a. The bartender thought the giraffe was a lion
b. Play on the word(s):_____(fill in the blank)
c. The man took a giraffe into a bar
d. The giraffe drank beer
e. Not sure

13. What’s Irish and sits outside?
Patio furniture.

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you “get” the joke?

What makes the joke funny?

a. “Patio furniture” could be the name of an Irish Setter
b. Patio furniture is made in Ireland
c. Furniture from Ireland belongs outside
d. Play on the word(s):_____(fill in the blank)
e. Not sure

14. Did you hear about the corduroy pillows?
They’re making headlines.

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you “get” the joke?

What makes the joke funny?

a. Corduroy pillows are in the news
b. Corduroy pillows are popular
c. Play on the word(s):_____(fill in the blank)
d. The tone of the speaker
e. Not sure

15. These 2 cannibals are eating a clown, and one stops and says, “Does this taste funny to you?”

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you “get” the joke?

What makes the joke funny?

a. The clown doesn’t taste right
b. Clowns are funny
c. Dual meaning of the word “taste”
d. Play on the word(s):_____(fill in the blank)
e. Not sure

16. Why do they put bells on cows?
Because their horns don't work.

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the joke?

What makes the joke funny?

a. Bells make noise
b. Play on the word(s):_____(fill in the blank)
c. Cows do not know how to play horns
d. Cow bells are only there for decoration
e. Not sure

17. How do you get down from an elephant?
You don't get down from an elephant. You get down from a goose.

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the joke?

What makes the joke funny?

a. Play on the word(s):_____(fill in the blank)
b. You cannot get off of an elephant, but you can get off of a goose
c. Dual meaning of the word "goose"
d. You cannot ride an elephant
e. Not sure

18. *Darth Vader*: Luke Skywalker, I know what you're getting for Christmas.
Luke Skywalker: How do you know?
Darth Vader: I felt your presence.

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the joke?

What makes the joke funny?

a. Darth Vader shook Luke Skywalker's presents
b. Dual meaning of the word "felt"
c. Play on the word(s):_____(fill in the blank)
d. The way that Darth Vader speaks causes a misinterpretation of what he is saying
e. Not sure

19. Why did the cookie visit the doctor? He felt crummy.

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the joke?

What makes the joke funny?

a. The cookie didn't feel well
b. Play on the word(s):_____(fill in the blank)
c. Dual meaning of the word "felt"
d. The cookie went to a doctor
e. Not sure

20. A snail walked into a new car showroom.
Snail: I want to buy a new car.
Salesman: Okay, what kind of car do you want?
Snail: I want a little car. And I want a big letter S on the side.
Salesman: Okay. Why?
Snail: Because when I drive down the street I want people to say "look at that little S car go."

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the joke?

What makes the joke funny?

a. Snails can't drive
b. The snail wants people to refer to its car as an S car
c. Play on the word(s):_____(fill in the blank)
d. The snail wants people to notice its car
e. Not sure

21. He was the number one laxative salesman in the whole United States, but he was just a regular guy.

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the joke?

What makes the joke funny?

a. Laxative implies irregular
b. Play on the word(s):_____(fill in the blank)
c. The salesman did not let his success go to his head
d. The man sold laxatives for a living
e. Not sure

22. Why is a moon rock tastier than an earth rock?
Because it's a little meatier.

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the joke?

What makes the joke funny?

a. Play on the word(s):_____(fill in the blank)
b. The meatier the rock the better
c. You don't eat rocks
d. The earth rock isn't meaty enough
e. Not sure

23. Why was the baby ant so confused?
Because all of its uncles were ants.

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the joke?

What makes the joke funny?

a. The baby ant expected that its relatives would be a different kind of insect
b. Play on the word(s):_____(fill in the blank)
c. The ant thought that its uncles were females
d. All ants look the same
e. Not sure

24. What do you call a guy who never farts in public?
A private tutor.

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the joke?

What makes the joke funny?

a. Tutor's are secretive about passing gas
b. The guy farts privately
c. Privates in the military are not allowed to pass gas in public
d. Play on the word(s):_____(fill in the blank)
e. Not sure

25. What did the fish say when he hit a concrete wall?
"Damn."

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you “get” the joke?

What makes the joke funny?

a. Fish don’t talk
b. Play on the word(s):_____(fill in the blank)
c. The fish didn’t see the concrete wall until it was too late
d. The fish realized that it swam into a dam
e. Not sure

26. Bert asked Ernie if he wanted ice cream and Ernie said, “Sure Bert.”

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you “get” the joke?

What makes the joke funny?

a. Play on the word(s):_____(fill in the blank)
b. Ernie didn’t tell Bert what flavor he wanted
c. Muppets don’t eat ice cream
d. Ernie misunderstood Bert
e. Not sure

27. What did the chick say when it saw an orange egg in the nest?
“Look at the orange mama laid.”

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you “get” the joke?

What makes the joke funny?

a. The chick thinks the egg is an orange
b. The egg is supposed to be white
c. The chick does not know what the orange egg really is
d. Play on the word(s):_____(fill in the blank)
e. Not sure

Semantic Jokes

1. 2 guys were walking their dogs, one with a German shepherd and the other with a Chihuahua. The man with the shepherd suggests going into a bar for a drink.
Man 2: They're not going to let dogs into the bar.
Man 1: Watch this.
He takes a pair of dark glasses and goes in and acts like the shepherd is his seeing eye dog. Hey says he wants a drink, and the bartender lets him in and pays no attention to the dog. The next guy puts some dark glasses on and takes his Chihuahua and goes in the bar.
Bartender: We don't allow dogs.
Man 2: Oh, it's a Seeing Eye dog.
Bartender: A Chihuahua is a Seeing Eye dog?
Man 2: They gave me a Chihuahua?

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the joke?

What makes the joke funny?

a. Chihuahuas are not Seeing Eye dogs
b. The man thought the bartender would think a Chihuahua could be a Seeing Eye dog
c. The man is pretending not to know what kind of dog he has
d. Play on the word(s):_____(fill in the blank)
e. Not sure

2. A Frenchman walks into a bar and he has a parrot on his shoulder, and the parrot has dark glasses on.
Bartender: Hey that's neat, where did you get that?
Parrot: I got him in France. They got millions of them there.

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the joke?

What makes the joke funny?

a. You expect that the Frenchman will respond
b. Play on the word(s):_____(fill in the blank)
c. The parrot is an interpreter for the Frenchman
d. The bartender is talking to the parrot instead of the Frenchman
e. Not sure

3. *Baby snake*: Mommy, are we poisonous?
Mommy snake: Why do you ask?
Baby snake: Because I just bit my tongue.

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the joke?

What makes the joke funny?

a. The baby snake bit its tongue
b. The baby snake does not know that it cannot poison itself
c. The baby snake does not know if it is poisonous
d. Play on the word(s):_____(fill in the blank)
e. Not sure

4. *Man (on the phone):* Hello. Is this the fire department?
Fireman: yeah.
Man: My house is on fire. You've got to come right away.
Fireman: Okay, how do we get to your house?
Man: You don't have those big red trucks anymore?

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the joke?

What makes the joke funny?

a. The fireman doesn't have transportation
b. The fireman doesn't know where the man lives
c. Play on the word(s):_____(fill in the blank)
d. The man misunderstood the fireman's question
e. Not sure

5. Did you hear about the invisible man who married the invisible woman?
Their kids aren't much to look at either.

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the joke?

What makes the joke funny?

a. You cannot see things that are invisible
b. Their children are not attractive
c. No one in the family is attractive
d. Play on the word(s):_____(fill in the blank)
e. Not sure

6. A man walked in to a bar and sat down and ordered a beer. He sat and drank it and he heard a little voice.
Little Voice: Nice tie.
Nobody was there except him and the bartender.
Little Voice: Really cool shirt too.
He thought he must have been losing his mind.
Little Voice: Hey, I like your hair that way.
Man (to the bartender): I keep hearing a voice.
Bartender: Well, those are the peanuts sir. They're complimentary.

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the joke?

What makes the joke funny?

a. The peanuts are talking
b. Play on the word(s):_____(fill in the blank)
c. The peanuts are flattering
d. The bartender pretends that the peanuts were talking when it was really him
e. Not sure

7. A man walks into a bar and orders a beer. He sips it and sets it down by the piano. The piano player's monkey swings over and pees in the glass.
Man: Hey do you know your monkey just peed in my glass?
Piano Player: No, but if you hum a few bars, I'll play it.

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the joke?

What makes the joke funny?

a. Play on the word(s):_____(fill in the blank)
b. The man wants to hear the song "your monkey just peed in my glass"
c. The man is upset that the monkey peed in his glass
d. The piano player thinks that the man wants to hear the song "your monkey just peed in my glass"
e. Not sure

8. A guy walks into a bar with a frog on his head.
Bartender: Hey, where did you get that?
Frog: Well, it just started out as a little bump on my butt.

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the joke?

What makes the joke funny?

a. The frog responds
b. Play on the word(s):_____(fill in the blank)
c. The man had a frog on his head instead of a hat
d. The bump on the frog's butt grew into a man
e. Not sure

9. A drill sergeant runs this platoon of recruits all over the camp. The sun is out and it's really hot, and they've got heavy packs on. As they finally come into the base, they're in formation and they're exhausted. The drill sergeant puts his face right up to one of the recruit's face.
Drill Sergeant: I bet you're wishing that I would die so that you could come and urinate on my grave, aren't you.
Recruit: Sir, no sir. When I get out of the army, I'm never going to stand in another line again.

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the joke?

What makes the joke funny?

a. The recruit is sick of standing in lines
b. The recruit is implying that a lot of people do not like the sergeant
c. The recruit thinks that a lot of people will visit the sergeant's grave
d. Play on the word(s):_____(fill in the blank)
e. Not sure

10. There's this old rancher in Montana, and he hates wearing seatbelts. One day he's driving on the highway with his wife, and he sees a state patrol car behind him.
Rancher (to his wife): Quick, take the wheel. I've got to put my seatbelt on.
So she does, and the patrolman pulls them over and walks up the car.
Patrolman: I noticed that you weren't wearing your seatbelt.
Rancher: I was too, but you don't have to take my word for it. My wife is a good Christian woman. You can ask her. She'll tell you the truth. She doesn't lie about anything.
Patrolman: So, how about it m'am?
Woman: I've been married to Buck for 20 years office, and one thing I've learned in all that time is this. You never argue with him when he's drunk.

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the joke?

What makes the joke funny?

a. The wife lies to the patrolman
b. The wife accidentally reveals that her husband wasn't wearing his seatbelt
c. The wife accidentally reveals that her husband is drunk
d. Play on the word(s):_____(fill in the blank)
e. Not sure

11. A kid was ice fishing. He cuts his hole in the ice, and he drops his line in. He has no luck for a really long period of time, but there's an old guy across the way who is just reeling them in. Every few seconds, he got a huge bounty of fish. Finally the little boy in frustration walks over to the old guy.
Boy: This is amazing. I can't catch anything, and I'm only a few feet away from you. How do you do it?
Old Man: rrr-rrr-rrr-rrr
Boy: I can't hear you.
Old Man: rrr-rrr-rrr-rrr
Finally, the old man goes (spit)
Old Man: keep your worms warm.

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the joke?

What makes the joke funny?

a. The old man had the worms in his mouth
b. Play on the word(s):_____(fill in the blank)
c. The old man can't speak very well
d. The old man had food in his mouth
e. Not sure

12. Two North Dakotans go into a bar and they buy drinks for everybody in the place. They are whooping it up and celebrating.
Bartender: What are you whooping it up for?
North Dakotan: We just finished a jigsaw puzzle. It only took us 2 months.
Bartender: 2 months? A jigsaw puzzle shouldn't take 2 months.
North Dakotan: Oh yeah, on the box it said 2 to 4 years.

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the joke?

What makes the joke funny?

a. The North Dakotans are not very good at puzzles, but they think they are
b. The North Dakotans misunderstood the box
c. It is silly for adults to celebrate the completion of a puzzle
d. Play on the word(s):_____(fill in the blank)
e. Not sure

13. This old man thought his wife was going deaf so he came up behind her and said, "Can you hear me sweetheart?" There was no reply, so he came a little closer and said it again. Still, no reply. So he spoke right into her ear and said, "Can you hear me now honey?"
Woman: For the third time, yes!

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the joke?

What makes the joke funny?

a. Play on the word(s):_____(fill in the blank)
b. The woman was not answering the man because he was getting on her nerves
c. The man forgot he had already asked her the same question
d. The man was really the one losing his hearing
e. Not sure

14. *Man:* Hello, doctor. My wife is pregnant, and her contractions are only 2 minutes apart.
Doctor: Is this her first child?
Man: No, this is her husband.

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the joke?

What makes the joke funny?

a. The doctor misunderstood the man
b. The man misunderstood the doctor
c. Play on the word(s):_____(fill in the blank)
d. The doctor thought she was talking to a child
e. Not sure

15. My wife is such a bad cook that they flies took up a collection to fix the screen door.

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the joke?

What makes the joke funny?

a. Play on the word(s):_____(fill in the blank)
b. The flies don't even like her food
c. If the screen door were fixed, she would be able to cook better
d. The flies wanted to prevent her from sharing the food with others
e. Not sure

16. *Man:* Doctor, I have this terrible problem. I think I'm a dog. I walk around on all fours, I keep barking in the middle of the night, and I eat dog food.
Doctor: That's very interesting. Why don't you lie down on the couch please.
Man: I'm not allowed on the couch.

How funny do you think the joke is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the joke?

What makes the joke funny?

a. The man believes that he has to abide by rules for a dog
b. Play on the word(s):_____(fill in the blank)
c. The man is afraid to get on the couch
d. Because he acts like a dog, the man's family does not allow him on the couch
e. Not sure

<u>Mr. Bean Film Clips</u>

1. *Crawling on the floor through the perfume section of the store.*

How funny do you think the film segment is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the humor?

What makes this film segment funny?

a. He has an exaggerated reaction to the perfume
b. He nearly bumped into another customer
c. No one else is bothered by the perfume odors
d. He is pretending that he is a dog in public
e. Not sure

2. *Warns woman not to go through the perfume section*

How funny do you think the film segment is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you “get” the humor?

What makes this film segment funny?

a. The perfume odors will be too strong for the woman
b. The woman really wants perfume
c. He assumes that the woman will have the same reaction as him
d. He doesn’t think she should buy perfume
e. Not sure

3. *He takes a toothbrush out of the package and uses it in a store while shopping.*

How funny do you think the film segment is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you “get” the humor?

What makes this film segment funny?

a. Brushing teeth in a store is disgusting
b. He shouldn’t do this in a store
c. He doesn’t care if anyone sees him
d. He wants to know if the toothbrush works right
e. Not sure

4. *Puts toothbrush back and takes another*.

How funny do you think the film segment is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you “get” the humor?

What makes this film segment funny?

a. He thinks that no one saw him
b. He wants an unopened one
c. His behavior exaggerated
d. His behavior is only appropriate for someone much younger
e. Not sure

5. *Wraps towel around himself while shopping and looks in the mirror.*

How funny do you think the film segment is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the humor?

What makes this film segment funny?

a. He has different values than others around him
b. He does funny poses in front of the mirror
c. He is concerned about how the towel looks on him
d. The towel he chooses is an odd color
e. Not sure

6. *He drops towel and covers his privates as if he were naked.*

How funny do you think the film segment is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the humor?

What makes this film segment funny?

a. His towel fell and exposed him
b. He thinks he is naked
c. He thinks that someone saw him
d. He makes a funny face
e. Not sure

7. *He pulls a potato out of his pocket and peels it.*

How funny do you think the film segment is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the humor?

What makes this film segment funny?

a. He had his own potato to test out the knife
b. His behavior was exaggerated
c. He does not care if anyone saw him
d. This kind of behavior is only okay for other people
e. Not sure

8. *Takes a fish out of his pocket and puts it in a pan.*

How funny do you think the film segment is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the humor?

What makes this film segment funny?

a. The fish is too big for the pan
b. He had been walking around with a fish in his pocket
c. His behavior is exaggerated
d. The fish looks sickly
e. Not sure

9. *Puts the first pan away and tries out a second pan.*

How funny do you think the film segment is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the humor?

What makes this film segment funny?

a. His is afraid that someone saw him
b. He hung a dirty pan back up
c. Everyone wishes they could do this in real life
d. The pan was not the right size
e. Not sure

10. *Tested out the phones for sale, then he took the real phone.*

How funny do you think the film segment is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the humor?

What makes this film segment funny?

a. The receptionist did not see him take her phone
b. He makes a mistake and takes someone's phone
c. He did not understand that the woman wanted that phone
d. He is acting like a child
e. Not sure

Charlie Chaplin Film Clips

1. *The man is working on assembly line. He keeps moving arms in the same motion as when he was working when walks away.*

How funny do you think the film segment is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the humor?

What makes this film segment funny?

a. His coworkers see him
b. He cannot control his muscles
c. His behavior is different than those around him
d. He is trying to make others laugh
e. Not sure

2. *The assembly line stops, but he keeps tightening things around him.*

How funny do you think the film segment is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the humor?

What makes this film segment funny?

a. He can't stop the repetitive movement
b. He is making everyone around him upset
c. He is not doing what he is supposed to be doing
d. He is obsessed with getting his work done
e. Not sure

3. *He dances around tightening noses, etc.*

How funny do you think the film segment is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the humor?

What makes this film segment funny?

a. His behavior is silly
b. He is breaking the rules
c. He loves his monotonous job
d. He is behaving like a child
e. Not sure

4. *Chases woman because he wants to tighten the buttons on her clothing.*

How funny do you think the film segment is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the humor?

What makes this film segment funny?

a. The woman misunderstands what he is trying to do
b. He thinks that his behavior is okay when it is not
c. The woman is afraid
d. He is obsessed w/ tightening things
e. Not sure

5. *He picks up a flag lying in the street. He waves it to get someone's attention & people start following him*

How funny do you think the film segment is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the humor?

What makes this film segment funny?

a. Everyone misunderstands what he is doing
b. He cannot get the attention of whomever dropped the flag
c. He is trying to get people to follow him
d. His behavior is exaggerated
e. Not sure

6. *The crowd runs from police & he crawls out of a hole in the street*

How funny do you think the film segment is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the humor?

What makes this film segment funny?

a. His appearance was unexpected
b. He does not know what happened to him
c. His behavior was exaggerated
d. He was the only one who got away
e. Not sure

7. *He is getting ready to eat and is looking away from his plate. Food appears on his plate, and he doesn't know where the food came from.*

How funny do you think the film segment is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the humor?

What makes this film segment funny?

a. His behavior is silly
b. He is unaware of where the food came from
c. He thought that someone was standing above him
d. His behavior is exaggerated
e. Not sure

8. *When he is eating, he accidentally smudges face unknowingly.*

How funny do you think the film segment is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

Did you "get" the humor?

What makes this film segment funny?

a. His behavior is exaggerated
b. He is trying to cover up his odd behavior
c. The people around him think he looks silly
d. He is unaware of what he did
e. Not sure

9. *Dives into shallow water*.

How funny do you think the film segment is?

Not Funny			Moderately Funny			Very Funny
1	2	3	4	5	6	7

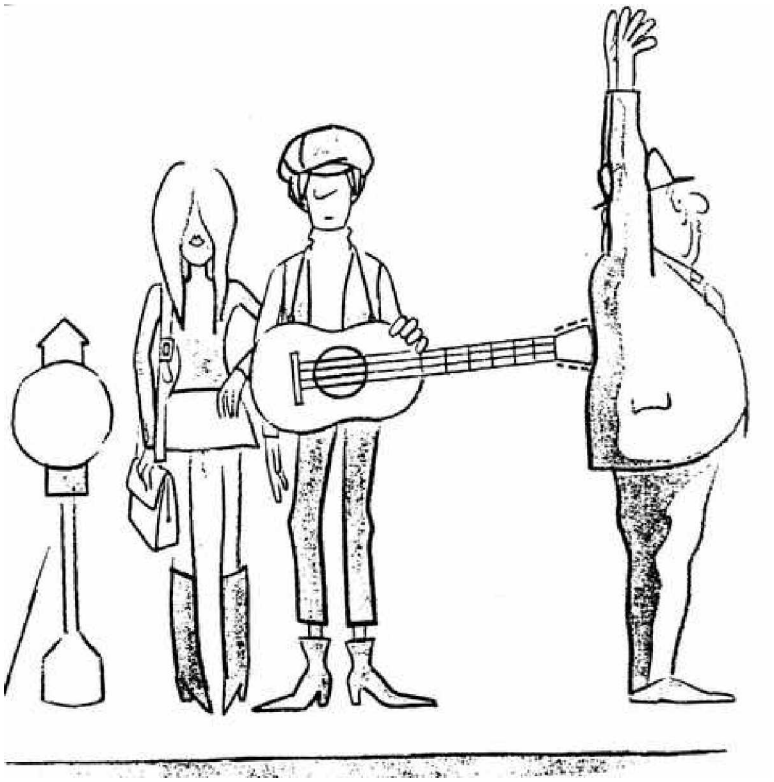
Did you "get" the humor?

What makes this film segment funny?

a. His swimming suit is weird
b. The water was too cold
c. His behavior was exaggerated
d. He misjudged the depth of the water
e. Not sure

Appendix B

Examples of Theory of Mind Cartoon Answers and Their Scoring



3 Points: The man thinks that he is being held up.

2 Points: The man does not see that it is a guitar pressed into his back.

1 Point: There is a guitar pressed into the man's back.

0 Points: Don't know.

Appendix C

Georgia State University

Department of Psychology

Informed Consent Form

Title: Humor Perception: the Contribution of Cognitive Factors

Principal Investigator: Erin Baldwin, MA
Dept. of Psychology

Research Rights: Research Office
(or related problems) Georgia State
University

Purpose: You are being asked to participate in a research study of humor perception. The purpose of this study is to examine the cognitive abilities that underlie humor. Your participation is requested because cognitive processes that underlie humor perception have not been studied in healthy individuals. You will be tested individually, and there will be a total of 84 participants in this study.

Procedures: You will be asked to watch film clips and listen to jokes. After hearing each joke and after watching each film clip, you will indicate if you understood ("got") the humor, and you will rate the funniness of the material. You will be asked to play a game on the computer. You will view four decks of cards and wil be asked to select from them. You will be given a computerized loan of $2000. Your goal will be to maximize profits and minimize losses. You will be presented with 14 cartoon drawings and will be asked to explain why each of them is funny. Lastly, you will complete several standardized and widely used measures of cognitive abilities. These measures will require you to repeat numbers and patterns, compare words, complete puzzles, and solve problems. You will interact only with the principal investigator. The study will take place in one testing session in the Psychology Department in the Urban Life Building. It will be approximately 2 hours. You will earn 2 hours of credit toward your intoductory Psychology course for participating in this study.

Risks: Because some of the cognitive measures may be difficult, there is a potential risk of increased stress associated with participating in this study.

Benefits: You may not benefit personally from this study; however, the knowledge that will be gained may benefit researchers and clinical populations in the future.

Voluntary Participation and Withdrawal: Participation in research is voluntary. You have the right to refuse to be in this study. If you decide to be in the study and change your mind, you have the right to drop out at any time. You may skip questions

or discontinue participation at any time. Whatever you decide, you will not lose any benefits to which you are otherwise entitled.

Confidentiality: We will keep your records private to the extent allowed by law. We will use a study number rather than your name on study records. Your name and other facts that might point to you will not appear when we present this study or publish its results. The findings will be summarized and reported in group form. You will not be identified personally.

Contact Persons: The experimenter will be happy to answer any questions that you might have about taking part in this study. If complaints or problems concerning this research project should arise, please call Dr. Mary Morris in the Department of Psychology at (404) 651-1620. If you have questions or concerns about your rights as a participant in this research study, you may contact Susan Vogtner in the Office of Research Integrity at 404-463-0674 or svogtner1@gsu.edu.

Copy of Consent Form to Subject: We will give you a copy of this consent form to keep.

If you are willing to volunteer for this research, please sign below.

_____	_____
Participant's Name (please print)	Date
_____	_____
Participant's Signature	Experimenter's Signature