A New Cognitive Perspective: The Revised Componential Model of Autism

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by

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ABSTRACT

A NEW COGNITIVE PERSPECTIVE: THE REVISED COMPONENTIAL MODEL OF AUTISM

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This thesis will discuss previous hypotheses for the cognition of autism and present a new model to more fully explain the cognition of autism. The Theory of Mind Hypothesis, the Executive Dysfunction Hypothesis, and the Weak Central Coherence Hypothesis will be noted as valuable but incomplete explanations of autism. These hypotheses all highlight the existence of a specific deficit in autism, but these deficits cannot singularly explain the cognition of autism. The Componential Model of Theory of Mind will be discussed as a more comprehensive explanation of autism that allows for multiple deficits in individuals with autism.

The Revised Componential Model will be introduced as a new model that generalizes the Componential Model of Theory of Mind beyond the social realm. This model will emphasize lower-level cognitive components, namely perception and processing. Furthermore, the model will show that lower-level cognitive components have a significant influence on higher-level cognitive components, including language, social cognition, and executive functions. This model will be supported through autobiographical accounts and research studies. Future directions for research on autism will be discussed.
A New Cognitive Perspective: The Revised Componential Model of Autism

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The phenotypic expression of autism is remarkably varied. From mental retardation to exceptional intelligence, from an absence of speech to a chatty overindulgence in speech, from aloof behavior to aggressive behavior, many diverse features are seen among individuals with autism. This extraordinary variance in phenotype makes it difficult to assign a universal explanation to the cognition of autism. In addition, autism is often characterized by its most noticeable features, including poor language and communication. Yet, theoretical perspectives on autism must also account for the less noticeable features of autism, such as abnormal perception and processing abilities.

The Theory of Mind Hypothesis, the Executive Dysfunction Hypothesis, and the Weak Central Coherence Hypothesis are three well-known theories that have attempted to identify one primary cognitive deficit in autism. Although these theories have contributed much valuable research to the field of autism, none of them can singularly explain the cognitive profile of autism. The Componential Model of Theory of Mind is an emerging explanation that allows for greater individual variation within the phenotype of autism. This model admirably explains the social functioning of individuals with autism, but it unfortunately does not explain the non-social functioning of individuals with autism.

In the present paper, the Componential Model of Theory of Mind will be adapted to additionally explain the non-social cognitive profile of autism. The Revised
Componential Model of autism will introduce two significant changes to the original hypothesis. First, it will include non-social cognitive components, namely perception and processing, as integral to the everyday functioning of autism. Second, the revised model will place a greater emphasis on the influence of lower-level cognitive components on higher-level cognitive components. With these changes, the Revised Componential Model will explain both the social and non-social functioning of individuals with autism.

AUTISM: THE COGNITIVE PROFILE

The Diagnostic and Statistical Manual of Mental Disorders – Fourth Edition – Text Revision (American Psychiatric Association, 2000) identifies three core impairments in autism. All three impairments must be present in order to establish a diagnosis of autism. Individuals with autism must show a “qualitative impairment in social interaction,” manifested by a lack of friendship with peers, an absence of social reciprocity, poor eye contact, etc. (American Psychiatric Association, 2000, p. 75). Second, individuals with autism must demonstrate “qualitative impairments in communication,” shown through delayed or absent speech, repetitive language, an absence of make-believe play, etc. (American Psychiatric Association, 2000, p. 75). Last, individuals with autism are characterized by “restricted, repetitive, and stereotyped patterns of behavior, interests, and activities” (American Psychiatric Association, 2000, p. 75). Repetitive movements, unusually strict adherence to a routine, and narrow, intense interests are used as indicators of the third impairment.
These three general impairments alone account for great variation within the phenotype of autism. The severity of these impairments and the precise manifestation of these impairments differ considerably from individual to individual. In addition, autism is often further characterized by cognitive impairments that are not included in the Diagnostic and Statistical Manual of Mental Disorders. While these impairments are not necessary for a diagnosis of autism, they are regularly observed in individuals with autism. A comprehensive theory of the cognition of autism must address and account for these additional impairments, as detailed below.

Individuals with autism often have a deficit in theory of mind ability, or the ability to infer mental states from human behavior. Recent research has more broadly framed this theory of mind deficit in terms of a social intelligence impairment (Tager-Flusberg, 2001). Individuals with autism may also have difficulty with executive functioning. Executive functioning is a general term used to encompass planning, set-shifting, working memory, inhibition, impulse control, and other brain-based skills. Perceptual and processing abnormalities, as discussed later in this paper, are common among individuals with autism (Frith, 2003).

Cognitive explanations of autism must consider both the unique intellectual capabilities and limitations of individuals with autism. While 75% of individuals with autism were once thought to have had mental retardation, recent analyses have examined the complete range of the autism spectrum and have found a lower incidence of mental retardation in autism (Frith, 2003). Keen and Ward (2004), for instance, surveyed 196 individuals with autism spectrum disorder, identifying 27.6% of these individuals with
comorbid mental retardation. Savant skills, or unexpected areas of talent in low-functioning individuals, are ten times more common in individuals with autism than non-autistic individuals with mental retardation (Happé, 1999). Individuals with autism who do not demonstrate savant skills still tend to show clear peaks and troughs in their skill development.

THREE POPULAR EXPLANATIONS: INCOMPLETE THEORIES OF AUTISM

The Theory of Mind Hypothesis, the Executive Dysfunction Hypothesis, and the Weak Central Coherence Hypothesis have all made important advances in autism research. The Theory of Mind Hypothesis and the Executive Dysfunction Hypothesis have identified valid cognitive deficits in autism, but these deficits have not been able to singularly explain the cognitive profile of autism. The Weak Central Coherence Hypothesis has identified a processing abnormality in autism, but recent research suggests that the term “weak central coherence” is not an accurate description of this abnormality. These three theories have made invaluable contributions to autism, but they simply cannot stand as unique and comprehensive explanations of the disorder.

The Theory of Mind Hypothesis

The Theory of Mind (TM) Hypothesis of autism proposes that individuals with autism do not appreciate mental states in themselves or others. This deficit in theory of
mind ability leads to other cognitive deficits that are characteristic of autism. Individuals with poor theory of mind ability will almost inevitably exhibit poor social skills and may choose to separate themselves from the confusing world of social interaction. Communication abilities may suffer with limited social interaction opportunities. Without the social world to draw their attention, these individuals may abnormally displace their attention and energy on stereotyped movements or obsessive interests (Baron-Cohen, 1995).

Tager-Flusberg (2001) notes five distinct challenges to the TM Hypothesis. First, theory of mind deficits are not universal among individuals with autism. Some individuals pass classic first-order theory of mind tasks, and a few even pass more complex, second-order theory of mind tasks (Ozonoff, Pennington, & Rogers, 1991). Second, theory of mind deficits are not specific to individuals with autism. As cited in Tager-Flusberg (2001), theory of mind deficits are also seen in individuals with mental retardation (Benson, Abbeduto, Short, Bibler-Nuccio, & Maas, 1993; Yirmiya, Erel, Shaked, & Solomonica-Levi, 1998; Zelazo, Burack, Benedetto, & Frye, 1996), deafness (de Villiers, 2000; Peterson & Siegal, 1995; 1998; Russell et al., 1998), blindness (Brown, Hobson, Lee, & Stevenson, 1997), and schizophrenia (Corcoran, 2000). Third, most of the tasks used to assess theory of mind ability in autism require skills that do not appear in typically developing children until approximately four years of age; yet, as cited in Tager-Flusberg (2001), many impairments in autism are witnessed before the age of four, such as deficits in empathy, joint attention, play, and imitation (Dawson &
Adams, 1984; Gillberg et al., 1990; Mundy & Sigman, 1989; Ornitz, Guthrie, & Farley, 1977; Volkmar et al., 1987).

Tager-Flusberg (2001) also objects that it is exceedingly difficult for the TM Hypothesis to explain the entire cognitive profile of autism. The connection between theory of mind impairments and a restricted repertoire of behaviors and interests is shaky at best, while the TM Hypothesis simply cannot explain other features of autism, including savant skills and sensory abnormalities (Plaisted, 2001). Finally, poor performance on theory of mind tasks may be secondary to deficits in executive functioning and/or language, as normal theory of mind task performance is influenced by the development of executive functioning and language abilities (Tager-Flusberg, 2001). Thus, the TM Hypothesis, while correctly identifying an impairment in theory of mind ability in autism (see Baron-Cohen, 2000, for a more complete review of the existence of a theory of mind impairment in autism), does not present a convincing case for an exclusively primary theory of mind impairment in autism.

The Executive Dysfunction Hypothesis

The Executive Dysfunction (ED) Hypothesis of autism states that individuals with autism have impaired executive functions, which leads to other cognitive deficits that are typical of autism. Individuals with a lack of mental flexibility, an executive function, may have difficulty changing their mental focus, resulting in obsessive behaviors and interests. Russell (1997) proposes that executive dysfunction may make it difficult for an
individual to differentiate between changes caused by the outside environment and changes caused by the self. This fundamental impairment in action monitoring may lead to a cascade effect, with subsequent impairments in self-awareness, the attribution of mental states, social interaction, and communication.

The objections that were raised to the TM Hypothesis can also be raised to the ED Hypothesis. First, executive dysfunction is not universal among individuals with autism. Young children with autism do not appear to have executive functioning deficits. After employing multiple executive functioning tasks, Dawson et al. (2002) and Griffith, Pennington, Wehner, and Rogers (1999) failed to find a difference in performance between young children with autism and mental-age matched controls. Furthermore, individuals with Asperger syndrome and high-functioning autism have been shown to outperform typically developing individuals on the Tower of London task, a test of executive functioning (Baron-Cohen, Wheelwright, Stone, & Rutherford, 1999). Second, executive dysfunction is not specific to individuals with autism. As cited in Hughes (2001), executive dysfunction is also apparent in individuals with attention deficit hyperactivity disorder (Grodzinsky & Diamond, 1992), Tourette syndrome (Baron-Cohen, Cross, Crowson, & Robertson, 1994), and conduct disorder (Chelune, Ferguson, Koon, & Dickey, 1986), among other developmental disabilities. Third, as cited in Tager-Flusberg (2001), many impairments that are characteristic of autism, including deficits in empathy, joint attention, play, and imitation (Dawson & Adams, 1984; Gillberg et al., 1990; Mundy & Sigman, 1989; Ornitz et al., 1977; Volkmar et al., 1987), appear before executive dysfunction in autism (Dawson et al., 2002; Griffith et al., 1999).
Fourth, the causal connection between executive dysfunction and social and communicative impairments is very weak. While there is certainly empirical support for a relationship between executive dysfunction and social and communicative impairments in autism (Hughes, 2001), there is little evidence that executive dysfunction is the exclusive cause of social and communicative impairments. Finally, it remains unclear whether executive dysfunction is a secondary symptom to general neurological damage in autism (Hughes, 2001). Thus, the ED Hypothesis, while correctly identifying an impairment in executive functioning in autism (see Hill, 2004, for a more complete review of the existence of executive dysfunction in autism), also does not present a convincing case for an exclusively primary executive functioning impairment in autism.

The Weak Central Coherence Hypothesis

The Weak Central Coherence (WCC) Hypothesis proposes that individuals with autism have weak global processing and strong local processing. Frith (2003) argues that repetitive behavior is the natural cognitive setting, with excessive repetitions normally stopped by a drive for central coherence. If individuals with autism have weak central coherence, they may not correctly receive the signal to cease repetitions. These repetitive behaviors and obsessive interests are not shared by other people and may therefore lead to a failure to develop appropriate social and communication skills. Happé (2001) further hypothesizes that a piecemeal processing style in individuals with autism may result in poor emotion recognition and theory of mind development.
Whereas the TM Hypothesis and the ED Hypothesis have been presented as correctly identifying a cognitive deficit in autism but incorrectly classifying this deficit as a primary deficit, the WCC Hypothesis will be critiqued on a more basic level. Although there is certainly evidence of a processing abnormality in autism, as this paper will later discuss, it is not clear that the term “weak central coherence” accurately describes this abnormality. This paper will briefly highlight a few recent research studies that show that the processing abnormality in autism may not be weak central coherence. See Plaisted (2001) for a more complete review of research that refutes the WCC Hypothesis.

Plaisted, O’Riordan, and Baron-Cohen (1998) used a visual search task to examine processing abilities in autism. Subjects were presented with a set of stimuli and were asked to identify whether or not the specific target stimulus was present within that set of stimuli. In the conjunctive search condition of this task, the target stimulus shared color with some distracting stimuli and shared shape with other distracting stimuli. The WCC Hypothesis predicts that individuals with autism would perform poorly on this task due to a decreased ability to integrate these two features, color and shape. Contrary to this prediction, the autism group was able to identify the presence or absence of the target stimulus significantly more quickly and more accurately than the control group. These results provide evidence against a deficit in global processing in autism.

In the Navon Task (Navon, 1977), subjects are presented with large letters that are composed of smaller letters. These smaller letters may or may not be the same letter as the larger letter. Typically developing individuals show two tendencies when asked to identify these letters. Subjects are generally quicker and more accurate at identifying the
large letters, termed the global advantage effect. Also, when incompatible letters are presented, subjects are slower to identify the small letters than the large letter, known as the global interference effect. The WCC Hypothesis, suggesting a deficit in global processing, would predict the absence of both of these effects in autism.

Plaisted, Swettenham, and Rees (1999) administered a modified version of the Navon Task to individuals with high-functioning autism and nonverbal IQ matched controls. In the selective attention condition of this task, subjects were primed to attend to either the large letter at the global level or the small letters at the local level and were then asked to identify the type of letter appearing at the appropriate level. Individuals with autism showed both the global advantage effect and the global interference effect in this condition. These results are in direct contradiction to the WCC Hypothesis.

Mottron, Burack, Stauder, and Robaey (1999) further evaluated the WCC Hypothesis by using a mental synthesis task. In this study, subjects were presented with two small figures and one large figure. Subjects were required to mentally combine the two smaller figures in order to evaluate whether they could naturally form the larger figure. The WCC Hypothesis would expect individuals with autism to perform well on this task, despite task difficulty, since they would not experience any interference from the global level of the larger figure. However, the autism group showed an increased reaction time for tasks of greater difficulty. This finding supports intact global processing in individuals with autism.

The WCC Hypothesis correctly identifies a processing abnormality in autism but incorrectly classifies this abnormality as weak central coherence. Recent research has
suggested alternative classifications of this processing abnormality, such as reduced
generalization (Plaisted, 2001), but a widely accepted conceptualization has not yet
emerged to replace weak central coherence. Consequently, much literature continues to
classify the processing abnormality in autism as weak central coherence, for lack of a
better alternative.

Rather than continue to refer to this abnormality by an erroneous term, this paper
will generally refer to a non-specified processing abnormality in autism. The Revised
Componential Model of autism, as introduced in this paper, will emphasize processing
abnormalities as integral to the cognition of autism, but this model will not attempt to
classify the exact nature of the processing abnormality in autism. Henceforth, the
processing abnormalities that have been traditionally classified as weak central coherence
will be generally denoted as processing abnormalities.

**THE COMPONENTIAL MODEL: A MORE COMPLETE THEORY OF AUTISM**

Tager-Flusberg (2001) recently introduced the Componential Model of Theory of
Mind (CMTM) Hypothesis to address the objections of the classic TM Hypothesis. In the
CMTM Hypothesis, theory of mind ability is regarded as just one step in the development
of social intelligence, with steps such as joint attention, imitation, and play leading up to
theory of mind ability, and steps such as morality issues and conversational abilities
extending beyond theory of mind ability. The CMTM Hypothesis maintains that this
general mentalizing ability, including both precursors and followers of theory of mind
ability, is affected by two components, the socio-perceptual component and the socio-cognitive component.

The socio-perceptual component emerges early in development, expanding upon the inborn preference of infants to attend to social stimuli and human faces. This innate tendency of infants leads them to begin processing facial features, an initial milestone in mentalizing ability. The socio-cognitive component appears later in development and builds upon the socio-perceptual component. By way of this later component, children expand their early mentalizing skills and become proficient at more advanced mentalizing tests, such as theory of mind tasks. Language and executive functioning abilities affect the development of the socio-cognitive component, with poor language and executing functioning abilities limiting mentalizing ability. Although Tager-Flusberg (2001) only provides a verbal description of her hypothesis, Figure 1 has been created to show a pictorial description of the CMTM Hypothesis (K.C. Plaisted, personal communication, 2004).

The CMTM Hypothesis has several distinct advantages over the prior cognitive theories of autism. While other theories tend to separately evaluate language, social cognition, and executive functioning, the CMTM Hypothesis acknowledges interaction among these cognitive components. The phenotypic expression of the socio-cognitive component of autism is influenced by all three of these areas. To illustrate with an example, some individuals with autism may be able to pass false belief tasks, compensating for poor social cognition with high language and executive functioning abilities (Tager-Flusberg, 2001). Second, the CMTM Hypothesis views cognitive deficits
within a gradient, rather than as an all or none phenomenon. To continue with the
previous example, social cognition cannot be solely determined by performance on a
false belief task. Rather, joint attention, play, empathy, imitation, and conversational
abilities all contribute to an individual’s facility for social cognition.

Third, as the CMTM Hypothesis does not endorse a single primary deficit in
autism, it is no longer problematic that some cognitive deficits are not universal in
autism. Due to the interaction among language, social cognition, and executive
functioning, some individuals with autism would be expected to pass false belief tasks,
while other individuals would not be expected to pass such tasks. The CMTM Hypothesis
also alleviates concerns about the specificity of cognitive deficits to autism. This
hypothesis proposes that the etiology of the cognitive deficits, rather than the deficits
themselves, is unique to autism. For instance, theory of mind impairment in children with
blindness may result from an inability to perceive facial expression, theory of mind
impairment in children with deafness may result from an inability to perceive speech, and
theory of mind impairment in children with mental retardation may result from general
low cognitive functioning. Although the phenotypic expression of these impairments is
similar, the developmental pathways leading to these impairments are different. Lastly,
by allowing for multiple deficits in autism, the CMTM Hypothesis more completely
explains the cognitive profile of autism (Tager-Flusberg, 2001).

Although the CMTM Hypothesis introduces clear advantages over the three
classic theories of autism, this hypothesis only explains the social functioning of autism.
Indeed, this hypothesis only attempts to explain the social functioning of autism, as both
the socio-perceptual component and the socio-cognitive component are inherently limited to the social realm. Thus, one prominent weakness of this hypothesis is its inattention to the non-social aspects of autism. A second weakness of the CMTM Hypothesis is its failure to account for the influence of lower-level cognitive components on higher-level cognitive components. While Tager-Flusberg (2001) acknowledges that deficits in the socio-cognitive component can “grow out of” deficits in the socio-perceptual component, the relationship between these components is not sufficiently emphasized (p. 183).

AN INTRODUCTION: THE REVISED COMPONENTIAL MODEL OF AUTISM

The Revised Componential Model (RCM) Hypothesis attempts to generalize the CMTM Hypothesis beyond the social realm. Instead of focusing on a socio-perceptual component and a socio-cognitive component in autism, the RCM Hypothesis generally focuses on lower-level cognitive components and higher-level cognitive components. Rather than specifically explain the social functioning of individuals with autism, the RCM Hypothesis endeavors to explain the overall functioning of individuals with autism. Two fundamental changes are introduced in the RCM Hypothesis. First, non-social lower-level cognitive process are included in the model, namely perception and processing. Second, there is a considerable emphasis on the influence of lower-level cognitive components on higher-level cognitive components. In this paper, research will be systematically presented to support both of these changes, as they respectively apply
to perception and processing. Figure 2 shows a pictorial description of the RCM Hypothesis, and these two essential changes are highlighted in red.

Support for the RCM Hypothesis is taken from two sources: autobiographical accounts of autism and research. Many researchers are leery of autobiographical accounts of autism, and they object to the subjective nature of such accounts. Conversely, this paper suggests that autobiographical accounts are valuable when employed in conjunction with empirical research. Autobiographical accounts offer a unique inside perspective on autism, and they should be appreciated for their rare insight. This paper will address the most common objections to autobiographical accounts before proceeding.

The most valid objection to first-hand accounts of autism is that these accounts are not representative of the autism spectrum. While these accounts are frequently from high-functioning, verbal individuals on the autism spectrum, these accounts are not exclusively from such individuals (Mukhopadhyay, 2003). Within the limits of self-report, autobiographical accounts provide valid insight into the personal experiences of the author, and they provide the closest available insight into the experiences of individuals with autism who cannot write their own autobiographies.

Another frequent objection is that the autobiographical memories of individuals with autism are not valid memories (O’Neill & Jones, 1997). These memories may be “echoed” memories, or subconsciously induced memories that reflect the general description of autism (O’Neill & Jones, 1997, p. 286). However, if autobiographical accounts were merely “echoed” memories, these accounts would be expected to
intimately correspond to the general description of autism (O’Neill & Jones, 1997, p. 286). Conversely, the general description of autism emphasizes poor social cognition, while autobiographical accounts of autism emphasize perceptual and processing abnormalities (Bogdashina, 2003).

Although objections can be raised to autobiographical accounts, these accounts offer a unique perspective on autism that presently available research does not provide. Autobiographical accounts are particularly valuable for recognizing non-salient abnormalities in autism, such as perception and processing abnormalities. While social and communicative deficits are very noticeable in autism, autobiographical accounts are able to identify the less noticeable deficits in autism. Autobiographical accounts do have their limitations, but when used in conjunction with research, they provide for a rich foundation to explore autism.

THE REVISED COMPONENTIAL MODEL OF AUTISM: PERCEPTION

For the purposes of the present paper, perception will be defined as the collection and interpretation of sensory information. The abnormalities included in this section of the paper are most accurately categorized as sensory-perceptual abnormalities. For simplicity and clarity, however, these abnormalities will be subsequently referred to as perceptual abnormalities.
Individuals with autism experience perceptual abnormalities in the five traditional senses, in addition to the kinaesthetic and proprioceptive senses. Using autobiographical and research descriptions, Harrison and Hare (2004) divide perceptual abnormalities in autism into seven qualitative categories. These seven categories will be briefly summarized, and autobiographical evidence will be presented to further illustrate these categories. This section of the paper will use autobiographical support to show that individuals with autism have severe perceptual abnormalities, or abnormalities in the sensory-perceptual realm.

Harrison and Hare (2004) identify hypersensitivity, an over-sensitivity to sensory input, and hyposensitivity, an under-sensitivity to sensory input, as the first category of perceptual abnormalities. Grandin describes her hypersensitivity in the auditory domain, “My hearing is like having a hearing aid with the volume control stuck on ‘super loud.’ It is like an open microphone that picks up everything” (Grandin, 1992, p. 107, as cited in O’Neill & Jones, 1997, p. 284). McKean (1994) expresses his visual hypersensitivity, “The color yellow is *blinding*. Looking at anything yellow is like looking directly into the sun, even if it is nowhere near as bright” (p. 66).

Sensory distortions are the second category of perceptual abnormalities. Perceptions may fluctuate between hypersensitivity, hyposensitivity, and normality. As one person with autism describes, “Sometimes when other kids spoke to me I would scarcely hear, then sometimes they sounded like bullets” (White & White, 1987, as cited
in Bogdashina, 2003, p. 66). Depth may be perceived incorrectly, as one individual depicts, “I broke my collar bone falling off a radiator. My eyes were showing a wide windowsill where the radiator was and I sat down falling off instantly” (White & White, 1987, p. 225, as cited in O’Neill & Jones, 1997, p. 284).

Individuals with autism may experience sensory overload, often caused by an inability to disregard irrelevant sensory information. Willey relates his experience with sensory overload, “Together, the sharp sounds and the bright lights were more than enough to overload my senses. My head would feel tight, my stomach would churn, and my pulse would run my heart ragged until I found a safety zone” (Willey, 1999, p. 22, as cited in Bogdashina, 2003, p. 80). Another individual with autism describes his personal coping mechanism for sensory overload:

If I’m looking at something and listening to something at the same time, too much information might come in my eyes and ears at one time, so I might touch. That gets information going in a different sense, through my touch, and it lets my eyes and ears have a rest. (Jones, Quigney, & Huws, 2003, p. 116)

Harrison and Hare (2004) also categorize sensory tune-outs as a perceptual abnormality in autism. Grandin illustrates her experience with sensory tune-outs:

Intensely preoccupied with the movement of the spinning coin or lid, I saw nothing or heard nothing. People around me were transparent. And no sound
intruded on my fixation. It was as if I were deaf. Even a sudden loud noise didn’t startle me from my world. (Grandin & Scariano, 1986, p. 23, as cited in O’Neill & Jones, 1997, p. 285)

In a related fifth perceptual abnormality, sensation is often fragmented. Individuals with autism may have difficulty simultaneously perceiving information through multiple sensory channels. Mukhopadhyay (2003) notes this difficulty, “When I concentrated on the sound, I felt my eyes and nose shutting off. I could never do everything together at the same time. That is, I could not see you and at the same time hear you” (p. 118).

Another individual with autism explains that he must shut off an active sensory channel in order to perceive information from a passive sensory channel. “I have caught myself turning off the car radio while trying to read a road sign, or turning off the kitchen appliances so that I could taste something” (Cesaroni & Garber, 1991, p. 306).

Some individuals with autism experience synaesthesia, a perceptual abnormality in which sensory stimulation is perceived through an incongruent sensory modality or through multiple sensory modalities. As one individual with autism explains, “It is possible … not only to see colors, but to smell them, too” (O’Neill, 1999, p. 29, as cited in Bogdashina, 2003, p. 125). Another individual perceives tactile stimulation on his lower face through both auditory and tactile sensory channels (Cesaroni & Garber, 1991). Harrison and Hare (2004) identify poor recognition of the modality of sensory stimulation as the seventh perceptual abnormality in autism. As one individual with autism attests, “Sometimes I know that something is coming in somewhere, but I can’t
tell right away what sense it’s coming through” (Cesaroni & Garber, 1991, p. 305). Poor recognition of the sensory modality in autism may also be linked to fragmented sensation in autism, as described above.

**Inclusion in the Model: Research Support**

Autobiographical accounts have provided strong support for the existence of perceptual abnormalities in autism. This section of the paper will use research support to show that individuals with autism have severe perceptual abnormalities. Unfortunately, research on perceptual abnormalities is limited. Due to a dearth of research on this subject, it is not possible to identify specific perceptual abnormalities via research. Rather, research will be used to support the general existence of perceptual abnormalities in autism. Furthermore, research will be presented to show that these perceptual abnormalities occur early in development.

Kientz and Dunn (1996) used the Sensory Profile (Dunn, 1994) to compare the perception of thirty-two children with autism or pervasive developmental disability to the perception of sixty-four typically developing children. Participants fell within the age range of 3-13 years, and parents were asked to complete the Sensory Profile, a measure of sensory processing, for their children. Children with autism differed significantly from typically developing children on all categories of the profile: activity level, auditory, body position, movement, emotional/social, taste/smell, touch, and vision. Furthermore, 85% of the questions on the profile showed a significant response difference between
individuals with and without autism. Dunn, Myles, and Orr (2002) used the modified Sensory Profile (Dunn, 1999) to compare the perception of forty-two children with Asperger syndrome and forty-two typically developing children. Participants in this study ranged in age from 8-14 years, and again, parents were asked to complete the Sensory Profile. Individuals with Asperger syndrome differed significantly from typically developing individuals on 22 of 23 sections on the modified Sensory Profile.

Talay-Ongan and Wood (2000) asked parents of thirty children with autism and thirty typically developing children to complete the Sensory Sensitivity Questionnaire – Revised, a measure of perceptual abnormalities in the auditory, gustatory, olfactory, tactile, vestibular, and visual domains. The children in this study ranged from 4-14 years old. This study has methodological advantages over the prior two studies, as participants were randomly selected from a nearby metropolitan area and controls were matched on age and gender. Once again, individuals with autism showed significantly greater sensory sensitivities than individuals without autism.

While the aforementioned studies support the existence of perceptual abnormalities in autism, they must be interpreted with caution. None of these studies matched participants on intelligence. Individuals with mental retardation often exhibit perceptual abnormalities, and it is not clear whether the perceptual abnormalities in these studies stemmed from mental retardation, autism, or a combination of both. Additionally, these studies do not pinpoint the existence of early perceptual abnormalities in autism. The influence of perceptual abnormalities on the development of higher-level cognitive components is more clearly seen when these abnormalities occur early in development.
Rogers, Hepburn, and Wehner (2003) address both of these concerns in their recent examination of perceptual abnormalities in toddlers with autism. They compare twenty-six toddlers with autism, twenty individuals with fragile X syndrome, thirty-two individuals with developmental delay, and twenty-four typically developing toddlers, all matched for mental age. This matching design alleviates the prior difficulty in discriminating between the effects of autism and low intelligence. Upon asking parents to complete the Short Sensory Profile (McIntosh, Miller, & Shyu, 1999), this study found an increased incidence of sensory symptoms in toddlers with autism, compared to typically developing toddlers and toddlers with developmental delay. At a mean age of 34 months, this young group enables the specification of early perceptual abnormalities in autism.

Retrospective video analysis has also been used to recognize early perceptual abnormalities in autism. Baranek (1999) analyzed home video recordings of eleven infants with autism, ten controls with developmental disabilities, and eleven typically developing controls. Four warning signs on the video recordings could distinguish infants with autism from other infants: poor nonsocial visual attention, delayed reaction to name, frequent placing of objects in the mouth, and aversion to social touch. All of these symptoms suggest abnormal perception in autism, while only some of these symptoms suggest abnormal social responsiveness in autism. Baranek (1999) recommends that both perceptual and social measures should be used to diagnose autism.

Gillberg et al. (1990) also endeavored to identify early indicators of autism, using a comprehensive methodology of clinical examinations, parent interviews, parent questionnaires, psychological tests, and neurological scans, among other approaches. In
this study, hearing and gaze abnormalities in infancy were found to be among the most
prominent early indicators of autism. Gillberg et al. (1990) directly concludes, “If autism
is to be recognized in infancy, the focus has to be shifted from the typical
speech/language problems to abnormal perceptual responses and various social
dysfunctions” (p. 933).

Influence on Higher-Level Cognitive Components: Autobiographical Support

The previous sections have established both the existence of perceptual
abnormalities in autism and the early appearance of these abnormalities in autism. As
these sections have demonstrated, abnormal perception plays an integral role in autism,
and perception is appropriately categorized as an influential lower-level cognitive
component in the RCM Hypothesis. The current section will use autobiographical support
to show that perceptual abnormalities have a significant impact on higher-level cognitive
components in autism.

Perceptual abnormalities, such as sensory overload, can cause an individual with
autism to retreat to his or her own world. Individuals with autism may avoid social
encounters because of the extreme perceptual stimulation associated these encounters. In
the third person, Mukhopadhyay (2003) describes his reaction to the playmates that his
mother would invite to their house, “Every evening they came home and played, while
the boy tried to hide. What a noisy group!” (p. 12) Another individual with autism
explains the appeal of his inner world, “The world inside my head is quiet and peaceful
and there are no people inside and nothing hard to figure out. So it is a safe place when
the real world gets too confusing …” (Jones et al., 2003, p. 117).

Perceptual abnormalities may also explain some of the unusual social behavior in
autism. Fragmented perception can make it very difficult for an individual with autism to
engage in a normal, reciprocal conversation. Subtle linguistic devices, such as sarcasm
and irony, may not be appreciated in an individual with irregular access to sensory
information. Telephone and computer communication is an important resource for
individuals with autism, as it forces sarcastic or ironic intent to be more explicit and it
limits communication to one sensory modality. Williams, for instance, prefers telephone
conversations over face-to-face conversations because information is only transmitted
through one sensory channel (Grandin, 1995). McKean (1994) prefers communication via
computer, as even less sensory information is transmitted through this process. McKean
(1994) refers to computers as “a god-send to the autistic population” (p. 49). He explains
that communication via computer “cuts down drastically on sensory overload” (McKean,
1994, p. 49).

Sensory sensitivity can also result in a low tolerance for social touch. When
individuals with autism negatively react to touch or fail to initiate touch, their behavior
may stem from perceptual abnormalities. Grandin depicts her simultaneous craving for
touch and fear of touch, “When I was a child I craved the feeling of being hugged but
then I withdrew because I was overwhelmed by the tidal wave of sensation” (Grandin,
simply describes the sensation of touch as “it hurts” and “it’s too much” (Cesaroni & Garber, 1991, p. 306).

Perceptual abnormalities may also lead to the third diagnostic criteria for autism, a restricted repertoire of behaviors and interests. Williams reports that repetitive behavior helped her block out confusing and unnecessary sensory stimulation, “Grinding my teeth kept disturbing, unpredictable, and meaningless outside noise from coming in. Singing a repetitive tune and humming continuously did the same. The tapping gave a continuous rhythm and stopped the unpatterned movement of others from invading” (Williams, 1994, p. 29-30, as cited in O’Neill & Jones, 1997, p. 285). Individuals with autism may also experience enjoyment from their abnormal perception and feel pleasure when engaging in repetitive behaviors and interests. As one person describes, “There are … personal rituals I do simply for sensory pleasure. They include rhythmic movements and sounds I make to myself. It fills my being with a sensual phenomenon, both serene and stimulating” (Jones et al., 2003, p. 119).

Finally, self-injurious, aggressive, and other undesirable behaviors may be partially explained by perceptual abnormalities. Grandin acknowledges that many unwelcome behaviors were attributable to sensory sensitivities, “Some episodes of bad behavior were directly caused by sensory difficulties. I often misbehaved in church and screamed because my Sunday clothes felt different” (Grandin & Scariano, 1986, as cited in Jones et al., 2003, p. 121). Mukhopadhyay (2003) reports that abnormal proprioception often instigated self-injurious actions, “It was very difficult to feel the complete body
In a classic study, Harlow and Zimmerman (1958) separated newborn monkeys from their biological mothers and introduced them to surrogate cloth and wire mothers. These infants, deprived from normal sensory contact with their mothers, developed very abnormal behaviors. When their surrogate mothers were removed from the room, the monkeys “would freeze in a crouched position, … [and] emotional indices such as vocalization, crouching, rocking, and sucking increased sharply” (Harlow & Zimmerman,
1958, p. 505). As the monkeys matured, they did not recover from their early sensory deprivation, and they failed to develop normal behavior.

Geldart, Mondloch, Maurer, de Schonen, and Brent (2002) examined face processing in individuals with bilateral congenital cataracts at birth. These participants were deprived of patterned visual stimulation from birth until surgical removal of the cataracts. Compared to controls, the participants, aged 10-38, had difficulty identifying the same person with a changed facial expression and identifying the same person with a changed head orientation. These results further emphasize the importance of normal sensory and perceptual input in development. Even short term visual deprivation can permanently impact higher-level cognitive components.

Russell et al. (1998) studied theory of mind development in deaf children. When deaf participants were given a false belief task, a common measure of theory of mind ability, they performed significantly lower on this task than their hearing counterparts. Russell et al. (1998) maintained that deaf children, by nature of their sensory impairment, had fewer opportunities to learn about mental states, which are often communicated linguistically. This lack of experience resulted in limited theory of mind ability and poor performance on false belief tasks. Blind children have also been shown to have initial difficulty with communication and social interaction (Brown et al., 1997).

These studies have shown the dire effects of sensory deprivation on normal development. While individuals with autism do not typically experience sensory deprivation, they do have significant difficulties with sensory perception. Given the extreme effects of sensory deprivation, abnormal sensory perception is likely to have a
lasting developmental impact. To further illustrate the importance of perceptual abnormalities in autism, this section will examine therapies that have specifically addressed sensation and perception in autism. When therapy is focused on these abnormalities, many of the core impairments in autism are diminished.

When massage therapy was regularly administered to eleven individuals with autism for one month, a number of significant changes emerged (Field et al., 1997). In general, touch aversion, unfocused behavior, attentiveness to irrelevant noises, and repetitive behavior all decreased. Participants were measured on the Autism Behavior Checklist and the Early Social Communication Scales before and after the massage therapy. After the massage therapy, participants showed fewer autistic tendencies on the sensory scale, the relating scale, and the total scale score of the Autism Behavior Checklist. Additionally, participants scored significantly better on measures of joint attention, behavior regulation, social behavior, and behavior initiation on the Early Social Communication Scales. Eleven individuals with autism regularly received a control touch therapy, sitting on a person’s lap, and these individuals did not improve to the same degree as those receiving massage therapy.

Bettison (1996) examined the long-term effects of auditory training on forty individuals with autism or Asperger syndrome. This treatment consisted of structured listening to music that had been personally modified for the participant. After ten days of auditory training, “many children were reported to begin seeking human interaction and display less oppositional and distressed behavior, show increased appropriate responses to other people and events, and increased spontaneous appropriate speech” (Bettison,
One year after the intervention, significant changes had been maintained on the Autism Behavior Checklist, the Developmental Behavior Checklist, the Sound Sensitivity Questionnaire, and the Peabody Picture Vocabulary Test, among other measures. These results demonstrate the positive effects of auditory training, another form of sensory-perceptual therapy. However, these results must be interpreted with caution, as the control group also experienced improvements after a control intervention of structured listening to unmodified music.

Case-Smith and Bryan (1999) provided occupational therapy with a sensory integration focus to five individuals with autism. This therapy was designed to meet the individual’s unique needs, using techniques such as brushing to provide tactile stimulation and swinging to provide vestibular stimulation. After ten weeks of intervention, four of the participants showed fewer nonengaged behaviors, or behaviors defined by minimal interaction with the environment. Three of the participants made significant improvements in age-appropriate, goal-directed play. Unfortunately, this study used a limited sample size and failed to employ control subjects. The prior studies have offered a brief sampling of sensory-perceptual therapies that have improved general functioning in individuals with autism.

Lastly, this section will discuss the effects of abnormal perception on neural plasticity. It is well-known that humans are born with an excess of synaptic neural connections (Greenough, Black, & Wallace, 1987). In early development, pruning occurs, in which active synapses are retained and passive synapses are eliminated. Mundy and Neal (2000) acknowledge the importance of the pruning process, and they identify two
main consequences of the pruning process in autism. First, integral synaptic connections may be lost in autism due to lack of activation. Second, abnormal early experiences in autism, such as perceptual experiences, may activate abnormal synaptic pathways. During pruning, these irregular yet active pathways will be maintained, resulting in an abiding and abnormal neural architecture. Thus, the perceptual impairments in autism are further compounded by an abnormal neural organization.

To briefly recapitulate, research has shown that normal sensory and perceptual input is necessary for normal development. As such, the abnormal perceptual experiences in autism have a significant effect upon the development of higher-level cognitive components. Sensory-perceptual therapies have been shown to diminish many of the basic impairments in individuals with autism, suggesting that perceptual abnormalities are a core deficit in autism. Finally, neural plasticity in individuals with autism can lead to an abnormal neural architecture, thus impacting higher-level cognitive components.

THE REVISED COMPONENTIAL MODEL OF AUTISM: PROCESSING

For the purposes of the present paper, processing will be defined as the manner in which external information is received and interpreted. The abnormalities included in this section of the paper are most accurately categorized as perceptual-processing abnormalities. For simplicity and clarity, however, these abnormalities will be subsequently referred to as processing abnormalities. As this paper continues, the distinction between perceptual and processing abnormalities will become somewhat
blurred. These abnormalities are best described on a sensory-perceptual-processing continuum, but they are presented separately in this paper in order to promote clarity.

Inclusion in the Model: Autobiographical Support

Autobiographical accounts have emphasized two key processing abnormalities in autism. First, individuals with autism have reported difficulty with generalization. They do not typically recognize similarities among objects, people, social situations, etc. As Blackburn attests, “I do not normally integrate things or see them as connected unless I actively look for a connection. I do not ‘draw’ connections …” (Blackburn, 1999, p. 10, as cited in Bogdashina, 2003, p. 45). Differences tend to be extremely salient, leading to impairments in basic categorization abilities. In the third person, Mukhopadhyay (2003) describes his difficulty in categorizing animals, as each animal seemed to be unique:

A picture of a dog on the book could be identified as a dog, but a street dog could not be identified. It took years and lots of practice by him and the patience of his mother who kept on asking him questions, comparing pictures of a dog or a cow with the living beasts on the roads and the zoo, to overcome this. (p. 9)

The second processing abnormality that is regularly noted in autobiographical accounts is piecemeal processing. Individuals with autism tend to perceive details, rather than an integrated whole. Williams illustrates this processing phenomenon, “Where
someone else may have seen ‘crowd’, I saw arm, person, mouth, face, hand, seat, person, eye … I was seeing ten thousand pictures to someone else’s one” (Williams, 1998, p. 21, as cited in Bogdashina, 2003, p. 68). For VanDalen, this piecemeal processing style is so extreme that he has difficulty recognizing solitary objects:

When I am confronted with a hammer, I am initially not confronted with a hammer at all but solely with a number of unrelated parts: I notify a cubical piece of iron within its neighborhood a coincidental bar-like piece of wood. After that, I am struck by the coincidental nature of the iron and the wooden thing resulting in the unifying perception of a hammerlike configuration. The name ‘hammer’ is not immediately within reach but appears when the configuration has been sufficiently stabilized over time. Finally, the use of a tool becomes clear when I realize that this perceptual configuration, known as ‘hammer’, can be used to do carpenter’s work. (VanDalen, 1995, p. 11, as cited in Bogdashina, 2003, p. 77)

Inclusion in the Model: Research Support

Autobiographical accounts have been used to support the existence of processing abnormalities in autism, and research studies will now be presented to further illustrate the role of processing abnormalities in autism. Happé (1999) suggests that there is evidence for processing abnormalities at three distinct levels. Following her lead, this
paper will examine cognitive studies that have shown processing abnormalities at the perceptual level, the visuospatial-constructional level, and the verbal-semantic level.

At the perceptual level, Happé (1996) presented a series of well-known visual illusions to individuals with autism, typically developing controls matched on verbal mental age, and controls with learning disabilities. The autism group was able to judge these illusions more accurately than both control groups. In a second condition of this study, the parts of the illusion that subjects were asked to judge were separated from the overall illusion by colored and raised outlines. Both control groups showed a significant improvement in performance on the second condition of this study, while the autism group did not improve significantly. Due to abnormal processing, individuals with autism were less fooled by visual illusions and less helped by modifications of the part of the illusion that was to be judged. However, as the performance of the autism group was originally high, it was less likely that modifications of the visual illusions would have led to an improvement in performance for the autism group.

DeGelder, Vroomen, and Van der Heide (1991) presented a series of auditory illusions to children with autism and children without autism, matched on sex and partially matched on score for the Peabody Picture Vocabulary Test. This study tested for the presence of the McGurk effect in autism, or for the tendency of lip movements and sounds to become blended into a single perception. Individuals with autism were less susceptible to the McGurk effect than controls, suggesting that lip movements and sounds were not integrated into a coherent whole in these participants.
The Embedded Figures Test involves identifying a hidden figure within a larger design. At the visuospatial-constructional level, Shah and Frith (1983) administered this test to children with autism, controls with mental retardation, and typically developing controls. The three groups were matched on sex and mental age, as estimated from the Raven’s Colored Progressive Matrices. The autism group outperformed both control groups on this task. Superior performance on the Embedded Figures Test involves dissociating the hidden figure from its broader context. The ability of individuals with autism to easily recognize this hidden figure supports strong piecemeal processing skills in autism.

The Block Design subtest on the Wechsler Scales of Intelligence is one task in which individuals with autism have consistently performed well. In this task, the subject is given a design and a set of building blocks in order to replicate the design. Shah and Frith (1993) created an experiment in which twenty individuals with autism, twelve individuals with learning disabilities, and thirty-three typically developing individuals were administered the Block Design test. The normally developing controls were matched to the autism group on nonverbal IQ, while the controls with learning disabilities were partially matched on nonverbal IQ and age. The first administration was the standard administration of the test, in which subjects were presented with a pattern and the building blocks to form that pattern. Individuals with autism performed better than controls, as expected. In the second administration, subjects were given building blocks and an overall pattern that was pre-segmented into components that corresponded to the blocks. In this condition, the performance of both control groups was improved, while the
performance of the autism group showed little improvement. These results suggest that individuals with autism have fewer tendencies to perceive the block pattern as a whole, and thus these individuals are less aided by pre-segmentation of the pattern. However, as the performance of the autism group was originally high, it was less likely that pre-segmentation would have led to an improvement in performance for the autism group.

At the verbal-semantic level, Happé (1997) used homograph pronunciation to measure processing in autism. Homographs are words with one spelling, but two different meanings and, in this study, two different pronunciations. Subjects were asked to read out loud sentences that contained homographs, such as “there was a big tear in her dress” or “there was a big tear in her eye” (Happé, 1997, p. 6). When sentence context preceded the homograph, the pronunciation of the typically developing control group was improved to a greater extent than the pronunciation of the autism group. These results suggest that individuals with autism do not use sentence meaning to aid in pronunciation due to processing abnormalities.

The above studies demonstrate a processing abnormality in autism. However, some of these studies must be interpreted with caution, as they do not provide a control group of individuals with developmental disabilities. There is a possibility that the abnormal performance of the autism group in some of these studies was caused by general low cognitive functioning, rather than abnormal processing. This possibility is unlikely, however, due to the sheer volume of studies that have included an appropriate control group and have still demonstrated abnormal performance in the autism group. See
this paper’s earlier section on the Weak Central Coherence Hypothesis for a brief discussion of the exact nature of the processing abnormality in autism.

*Influence on Higher-Level Cognitive Components: Autobiographical Support*

As the previous sections have demonstrated, abnormal processing plays an integral role in autism, and processing is appropriately categorized as an influential lower-level cognitive component in the RCM Hypothesis. The current section will use autobiographical support to show that processing abnormalities have a significant impact on higher-level cognitive components in autism.

Difficulties with generalization can have a considerable influence on social and communicative functioning. Mukhopadhyay (2003) used a board to communicate with his mother, but he had difficulty using the same board to communicate with other people. The salient difference of his mother’s absence and another person’s presence made it difficult for him to generalize his board communication skills. As he describes in the third person, “He could not get used to someone else holding the board. The problem was that he needed time to get used to the person – his touch and most important – his voice” (Mukhopadhyay, 2003, p. 45). Williams explains how poor generalization skills affected her behavior:

> The significance of what people said to me, when it sank in as more than just words, was always taken to apply only to that particular moment or situation.
Thus, when I once received a serious lecture about writing graffiti on Parliament House during a class trip, I agreed that I’d never do this again and then, ten minutes later, was caught outside writing different graffiti on the school wall. To me, I was not ignoring what I had been told, nor was I trying to be funny; I had not done exactly the same thing as I had done before. (Williams, 1992, p. 69, as cited in Klinger & Dawson, 1995, p. 119)

Piecemeal processing can greatly affect everyday functioning. Perceptions must be put in the proper context in order to extract meaning from them. To simply maneuver in the world, it is necessary to continually evaluate depth, distance, speed, etc., all of which require processing in context. One individual with autism describes the basic difficulties that piecemeal processing causes:

I have terrible difficulty in deciphering where anything is around me, or how fast something is moving or how near or far it is from me. An infinity of ‘twilight zone’ effects can result, causing all kinds of accidents, near misses, and other unassorted mayhem. (Jones et al., 2003, p. 116-117)

Piecemeal processing certainly has an effect on face processing, which has further implications for social and communicative functioning. One person with autism notes that he simply could not process faces as a complete entity, “I did not see whole. I saw
Influence on Higher-Level Cognitive Components: Research Support

This paper has already presented autobiographical accounts to show the influence of processing on higher-level cognitive components. Four lines of research will now be presented to further illustrate the effects of abnormal processing. First, the effects of poor generalization skills will be discussed. Second, the consequences of piecemeal processing will be addressed. The correlation between abnormal processing and theory of mind impairments will be examined, and finally, the effects of abnormal early experiences on neural plasticity will again be emphasized.

Rincover and Koegel (1975) examined the effects of poor generalization skills in autism. In this study, children with autism were taught a new behavior in a treatment room with one therapist. After this behavior had been mastered, the behavior was then assessed in an outdoor setting with an unfamiliar therapist. Four of ten individuals with autism could not transfer the behavior to this new setting. Of the remaining six individuals, none completely transferred the behavior to the new setting, with correct response rates ranging from 30% to 80%. However, as a control group was not included in this study, it is not possible to compare the processing skills of individuals with autism to the processing skills of individuals without autism or individuals with mental retardation.
In a similar generalization study conducted by Ferrara and Hill (1980), ten children with autism were compared to ten children without autism, loosely matched on mental age. Participants received toys under either predictable or unpredictable conditions. In the predictable condition, a light panel was illuminated directly before the toys appeared. In the unpredictable condition, the light panel was illuminated a variable amount of time before the toys appeared. While typically developing individuals reacted similarly to the toys during both conditions, individuals with autism looked at the toys and played with the toys more during the predictable condition. These results show that individuals with autism have difficulty generalizing their behavior from the predictable condition to their behavior in the unpredictable condition.

Piecemeal processing likewise has an effect on higher-level cognitive components. Alcántara, Weisblatt, Moore, and Bolton (2004) investigated speech-in-noise perception in eleven adolescents and adults with autism and nine age and IQ matched controls. While listening, individuals typically make connections between temporal dips, or moments with little competing background speech, to infer the overall message of the communication. For this experiment, subjects listened to a recording of a speaker with background noise, and they were asked to repeat the words of the speaker. When the background noise contained temporal dips, individuals with autism performed significantly worse than controls. When the background noise did not contain temporal dips, individuals with autism did not perform significantly worse than controls. Alcántara et al. (2004) suggest that speech-in-noise perception difficulties in autism may be caused by a reduced ability to process temporal dips in context. These results have implications
for social and communicative functioning, as the perception and comprehension of speech is integral to social interaction.

Blake, Turner, Smoski, Pozdol, and Stone (2003) administered a biological motion task to individuals with autism and typically developing individuals. In this task, subjects had to determine whether a point-light animation was or was not moving like a person. Individuals with autism were shown to be significantly impaired on this task, compared to controls. As individuals with autism were not impaired on a stimulus identification control task, Blake et al. (2003) suggest that piecemeal processing is the cause of this impairment. Difficulty in identifying biological motion can result in social and communicative impairments. For instance, individuals with autism may not orient to another person’s change in attention if they cannot integrate the local head and eye movements that are indicative of that person’s global change in direction.

Piecemeal processing also has an effect on the perception of facial expressions. Bormann-Kischkel, Vilsmeier, and Baude (1995) used the Emotions Task to determine that children and adults with autism had difficulty extracting emotions from a face, particularly complex emotions. If individuals with autism perceive the features of a face through piecemeal processing, this impairment is not unexpected. A solitary mouth or eye cannot signal an emotion.

In a recent study, Jarrold, Butler, Cottington, and Jiminez (2000) identified a relationship between abnormal processing and theory of mind ability. In the general population, they found a significant negative correlation between performance on an eye-reading task and speed on the Embedded Figures Test. After controlling for age and
verbal mental age, significant negative correlations between theory of mind ability and piecemeal processing ability, as assessed by the block design test and the Embedded Figures Test, were also seen in typically developing children and children with autism. Although these results do not indicate causation, they do demonstrate a close association between processing and social and communicative impairments in autism.

Lastly, this section of the paper will again emphasize the effects of abnormal early experiences on neural plasticity. As Mundy and Neal (2000) note, abnormal early experiences, such as processing experiences, may activate abnormal synaptic pathways. During pruning, this irregular neural activation may lead to an abiding and abnormal neural architecture. Processing abnormalities in autism may therefore be further compounded by an abnormal neural structure.

To briefly summarize, processing abnormalities have a significant impact on higher-level cognitive components. Difficulty with generalization may prevent individuals with autism from transferring skills to a separate setting. Piecemeal processing may preclude individuals with autism from extracting pertinent information from a stimulus in context. Both of these impairments have implications for higher-level cognitive components, as further demonstrated by a correlation between processing abnormalities and theory of mind ability. Finally, early processing abnormalities may lead to an abnormal neural architecture, thus greatly impacting later development.
CONCLUSION

The TM, ED, and WCC Hypotheses have all been influential in autism research, but recent research suggests that these hypotheses cannot sufficiently explain the cognitive profile of autism. The CMTM Hypothesis has adapted the TM Hypothesis to more thoroughly explain the social functioning of individuals with autism. Yet, even this hypothesis is not an adequate explanation, as it does not address the non-social functioning of individuals with autism. By revising the CMTM Hypothesis to explain the general functioning of individuals with autism, the RCM Hypothesis retains the advantages of the CMTM Hypothesis and introduces additional advantages.

The RCM Hypothesis more completely explains the cognitive profile of autism. It directly addresses impairments that the CMTM Hypothesis does not acknowledge, such as perceptual and processing abnormalities in autism. This hypothesis additionally emphasizes greater interaction among cognitive components, including the influence of lower-level cognitive components on higher-level cognitive components. The RCM Hypothesis is thus a more comprehensive and flexible adaptation of the CMTM Hypothesis.

Directions for Future Research

The RCM Hypothesis is an important milestone in the comprehension of autism, but future research is needed to clarify the thoughts and ideas generated in this paper. On
a general level, much of the research in this paper has been conducted on fairly high-functioning individuals with autism. While the studies on high-functioning individuals are thought to generalize to low-functioning individuals, empirical research is needed to support this assumption. Furthermore, individuals with autism need to be more judiciously matched with control subjects in future studies. Many studies fail to include an appropriately matched control group, making it difficult to evaluate the results of the study. Finally, researchers should also be more aware of the perceptual, processing, communicative, and social demands of their research. In much research, subtle experimental confounds make it difficult to pinpoint the precise cause of significant differences among research participants.

This paper has offered much support for the interaction between lower-level cognitive components and higher-level cognitive components, but the interaction among cognitive components may be more extensive than the RCM Hypothesis suggests. Future research should explore interaction among the individual cognitive components, such as the influence of social cognition on language. Also, it is necessary to empirically examine the influence of abnormal early experiences on neural plasticity. Research is needed to confirm the existence of this influence and to investigate the extent of this influence.

With respect to perceptual abnormalities, research needs to corroborate the existence of the seven perceptual abnormalities presented by Harrison and Hare (2004). Further studies need to more clearly illuminate the specific effects of perceptual abnormalities on higher-level cognitive processes. Lastly, while sensory input is clearly
necessary for normal development, the precise quality and quantity of this sensory input needs to be more carefully considered.

In the realm of processing, future studies need to clarify the exact processing abnormality in autism. If weak central coherence is not an accurate description of this abnormality, than a more accurate description needs to be generated. Heretofore, much of the research on processing has focused on piecemeal processing and weak central coherence. Difficulty with generalization in autism needs to be further empirically investigated. In addition, it is currently unclear whether poor processing in one domain, local or global, necessarily implies strong processing in the other domain, local or global. Finally, the precise effects of processing abnormalities on higher-level cognitive components need to be more carefully delineated.

In order to provide further support for the RCM Hypothesis, these areas of perception and processing must be investigated. Additional research in these areas may result in the early detection of autism and the implementation of early intervention measures for autism. At a time when the diagnosis of autism is increasing (Keen & Ward, 2004), the need for future research and theory cannot be underestimated.
References


Figure 1. The Componential Model of Theory of Mind.
Figure 2. The Revised Componential Model.