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**TRENDS IN CHILDREN'S AND ADULTS' UNDERSTANDING OF THE
LOCALIZATION OF COGNITION, EMOTION, AND PERSONALITY IN THE
BRAIN VERSUS OTHER PARTS OF THE BODY**

DISSERTATION

Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the
Graduate School of The Ohio State University

By

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* * * * *

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ABSTRACT

Four hundred and four 3rd, 5th, and 6th graders and college students were interviewed to investigate age trends in the understanding of the brain's central role in the processes of cognition, emotion, and personality, as opposed to other peripheral structures of the body. Four different questions formats were used: forced-choice, open-ended, brain switch, and other body part switch. Major variables included the central/peripheral factor (differences in responses to psychological processes associated with the brain as opposed to other parts of the body) and the psychological domain variable (participants' understanding of the three different domains).

Hypothesis I postulated that participants should demonstrate the same type of understanding about each psychological domain and central/peripheral processing across question types. This hypothesis was not supported, as significant differences emerged in participants' responses to the four question formats. It is likely that children's theories about a given psychological domain are inconsistent across tasks.

Hypothesis II postulated that there would be an overall trend from peripheral to central control of psychological processes with age. Responses

to the central versus peripheral items between grade levels supported the age trends proposed across all but one of the question formats.

Hypothesis III postulated that performance on central versus peripheral items within psychological domains would highlight developmental differences. Regardless of question format, the three youngest grade levels all performed significantly higher on central than peripheral items. Significant differences also emerged between college students' performance on central versus peripheral items for two question types. Question formats and participants' explanations of responses are examined to explain these unexpected findings.

Hypothesis IV postulated that participants would understand the role of the brain in cognition before emotion and personality, respectively. This hypothesis was supported with regard to cognition, but not for emotion versus personality. In every significant comparison that emerged between these two domains, scores for personality were higher than for emotion.

Hypothesis V postulated that by 6th grade, understanding of the brain's control of psychological processes would be equivalent to college students. This hypothesis was not supported. One possible explanation is that 6th graders participating in this study were exceptionally low-functioning.

Dedicated to my grandmother, D. Shirley Lunsford

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TABLE OF CONTENTS

	<u>Page</u>
Abstract	ii
Dedication	iv
Acknowledgments	v
Vita	vi
List of Tables	ix
Chapters	
1. Introduction	1
1.1 Purpose of Study	3
2. Literature Review	5
2.1 Theory-Theory Approach	5
2.2 Children's Understanding of Psychological Processes	11
2.3 Hypotheses	23
3. Methods	25
3.1 Participants	25
3.2 Measures	27
3.3 Procedure	34
4. Results	36
4.1 Overall Analysis of Variance	37
4.2 Examination of Responses to Forced-Choice Questions	41
4.3 Examination of Responses to Open-Ended Questions	60
4.4 Examination of Responses to Brain Switch Questions	76
4.5 Examination of Responses to Other Body Part Switch Questions	84

5.	Discussion	95
5.1	Question Format	95
5.2	Responses to Central and Peripheral Items	99
5.3	Understanding of Psychological Domains	105
5.4	Summary	113
	Appendices	116
A.	Sample Parent Letter and Consent Form	116
B.	Test Conditions	119
C.	Summary of Indianola Middle School's and Columbus City School District's Performance on the Ohio Sixth Grade Proficiency Test . . .	131
	List of References	134

LIST OF TABLES

<u>Table</u>	<u>Page</u>
1. Analysis of Variance Results for Effects of Grade, Condition, Psychological Domain, and Central/Peripheral Items on Participant Responses	40
2. Analysis of Variance Results for Effects of Grade, Psychological Domain, and Central/Peripheral Items on Participant Responses to Forced Choice Questions (Condition 1)	43
3. Analysis of Variance Results for Effects of Grade and Central/Peripheral Items on Participant Responses to Forced Choice Questions - Cognition (Condition 1)	49
4. Significant Differences Between Central and Peripheral Items Within Grades for Forced Choice Questions - Cognition (Condition 1)	49
5. Significant Differences for Central and Peripheral Items Between Grades for Forced Choice Questions - Cognition (Condition 1)	50
6. Analysis of Variance Results for Effects of Grade and Central/Peripheral Items on Participant Responses to Forced Choice Questions - Emotion (Condition 1)	51
7. Significant Differences Between Central and Peripheral Items Within Grades for Forced Choice Questions - Emotion (Condition 1)	51
8. Significant Differences for Central and Peripheral Items Between Grades for Forced Choice Questions - Emotion (Condition 1)	52

9.	Analysis of Variance Results for Effects of Grade and Central/Peripheral Items on Participant Responses to Forced Choice Questions - Personality (Condition 1)	53
10.	Significant Differences Between Central and Peripheral Items Within Grades for Forced Choice Questions - Personality (Condition 1)	53
11.	Significant Differences for Central and Peripheral Items Between Grades for Forced Choice Questions - Personality (Condition 1)	54
12.	Analysis of Variance Results for Effects of Grade and Psychological Domain on Participant Responses to Forced Choice Questions - Central (Condition 1)	59
13.	Analysis of Variance Results for Effects of Grade and Psychological Domain on Participant Responses to Forced Choice Questions - Peripheral (Condition 1)	59
14.	Analysis of Variance Results for Effects of Grade, Psychological Domain, and Central/Peripheral Items on Participant Responses to Open-Ended Questions (Condition 2)	63
15.	Significant Differences Between Central and Peripheral Items Within Grades for Open-Ended Questions (Condition 2)	66
16.	Significant Differences for Central and Peripheral Items Between Grades for Open-Ended Questions (Condition 2)	67
17.	Significant Differences for Psychological Domain Within Grades for Open-Ended Questions (Condition 2)	71
18.	Significant Differences for Psychological Domain Between Grades for Open-Ended Questions (Condition 2)	72
19.	Means for the Interaction of Psychological Domain and Central/Peripheral Items for Open-Ended Questions (Condition 2) ..	74

20.	Analysis of Variance Results for Effects of Grade, Psychological Domain, and Central/Peripheral Items on Participant Responses to Brain Switch Questions (Condition 3)	78
21.	Significant Differences Between Central and Peripheral Items Within Grades for Brain Switch Questions (Condition 3).	79
22.	Significant Differences of Psychological Domain Across all Grades for Brain Switch Questions (Condition 3).	80
23.	Significant Differences for Psychological Domain Within Grades for Brain Switch Questions (Condition 3)	81
24.	Means for the Interaction of Psychological Domain and Central/Peripheral Items for Brain Switch Questions (Condition 3) . .	82
25.	Analysis of Variance Results for Effects of Grade, Psychological Domain, and Central/Peripheral Items on Participant Responses to Other Body Part Switch Questions (Condition 4)	86
26.	Significant Differences Between Central and Peripheral Items Within Grades for Other Body Part Switch Questions (Condition 4). .	87
27.	Significant Differences for Psychological Domain Within Grades for Other Body Part Switch Questions (Condition 4)	91
28.	Significant Differences for Psychological Domain Between Grades for Other Body Part Switch Questions (Condition 4)	92
29.	Means for the Interaction of Psychological Domain and Central/Peripheral Items for Other Body Part Switch Questions (Condition 4)	93

CHAPTER 1

INTRODUCTION

In recent years, there has been an explosion of interest in children's early understanding of the mind. Research that tackles this question has come to be called "children's theory of mind." Theory of mind is the understanding that people have mental states, such as feelings, desires, beliefs, and intentions, and that these states underlie and help to explain their behavior (Berk, 1999). Children's early conceptions of the mind are implicit naive theories and changes in those conceptions are theory changes. This position is the basis for one of the most influential contemporary constructivist theories to emerge during the post-Piaget era in field of developmental psychology, the *theory-theory* approach (Gopnik, 1996). The theory-theory approach is the idea that cognitive development in children is the result of the same kinds of mechanisms that lead to theory change in science (Gopnik & Wellman, 1994). In science, theories have rules and they are representations of the world. Scientific theories are coherent, they have explanatory power, they allow for predictions, and they produce

interpretations of evidence (Gopnik, 1996). Over time, theories change. Rules and representations of the world cause scientific theories to change. They may also be responsible for cognitive development in children (Gopnik & Wellman, 1994).

In contrast to the theory-theory approach, findings from long-standing research programs investigating children's and adults' understanding of memory, identity, emotion, and vision (Gottfried, Gelman, & Schultz, 1999; Johnson, 1990; Johnson & Wellman, 1982; Winer, Cottrell, Bica, & Fournier, 1999) question the assertion that development reflects cognitive restructuring representing a radical re-conceptualization of beliefs. Specifically, results suggesting that separate belief systems may co-exist in the same individual, that beliefs may vary depending on context, and that certain incorrect beliefs may actually increase with age, are issues that must be addressed by theory-theory. Consideration of specific findings from studies focusing on children's understanding of memory, identity, and emotion (Gottfried, Gelman, & Schultz, 1999; Johnson, 1990; Johnson & Wellman, 1982; Winer, Cottrell, Bica, & Fournier, 1999) are needed, as are additional studies focusing on developmental trends in children's understanding of a variety of other psychological processes.

Purpose of the Study

The purpose of the current study is to contribute to the knowledge base on children's understanding of psychological processes and the misconceptions they hold about these processes. Specifically, this study investigated developmental trends in children's understanding that the brain plays a central role in the control of cognition, emotion, and personality, as opposed to control by other peripheral structures of the body such as the heart, stomach, eyes, and face. Findings from this study will be compared with those of other researchers investigating children's understanding of psychological processes.

There are multiple reasons for examining whether psychological processes are localized in the brain as opposed to other parts of the body. For one, traditional theory of mind researchers have argued that the young child's mental understanding is relatively sophisticated, while other findings suggest a much less complete understanding of psychological processes. The current study can be seen as an attempt to expand, as well as an attempt to challenge, certain aspects of the theory-theory approach in the domain of

children's understanding of the source or location of emotion, cognition, and personality.

Secondly, in coming to understand that the brain is the location of identity, emotion, cognition, and personality, children are acquiring a core piece of Western folk psychology. While all cultures distinguish inner aspects of the self, Western cultures are known to particularly emphasize the private, enduring psychological qualities of identity (Heelas & Lock, 1981; Shweder & Bourne, 1984). A more "archaic" piece of folk psychology is also examined in studies that examine children's understanding of psychological processes. Specifically, children's notions that other body parts play a role in psychological processes (e.g., the heart as the source of kindness and feelings or the face as the primary representation of the self) are examined (Harter, 1983; Johnson, 1990). The current study will contribute to the understanding of how children make sense of a proliferation of cultural information, ranging from the archaic to the scientific, in acquiring their own theory of mind.

CHAPTER 2

LITERATURE REVIEW

Theory-Theory Approach

With the cognitive revolution in psychology has come an enormous interest in children's early understanding of the mind, or theory of mind. Slaughter and Gopnik (1996) indicate that theory of mind reflects the position that one's everyday conception of the mind is an implicit naive theory. Children's early conceptions of the mind are also implicit theories and changes in those conceptions are theory changes (Gopnik & Wellman, 1994). These explanatory positions form the basis for one of the most influential contemporary constructivist theories, the theory-theory approach.

Although proponents of theory-theory indicate that children's understanding of the mind is a theory, they do not believe that this understanding is an explicitly formulated theory, nor do they believe that children's cognitive enterprises are identical to those of adult scientists (Gopnik & Wellman, 1994). What proponents do argue, however, is that scientific theory change and conceptual change in childhood are both the

product of human minds trying to understand the world (Gopnik, 1996). The approach that has come to be known as theory-theory suggests that there are striking similarities between the underlying cognitive mechanisms involved in the epistemological endeavors of childhood and of science (Gopnik & Wellman, 1994). The capacities for logical reasoning are in place very early in childhood, possibly from birth. The progress of science reflects the fundamental processes of conceptual change that are first seen in very young children. The point of theory-theory is not to demonstrate that what children do is identical to what scientists do, but to use scientific notions as the foundation for characterizing central aspects of children's cognitive development (Gopnik and Wellman, 1994).

Theory theorists indicate that scientific theories are abstract and coherent, have explanatory power, allow for predictions, and produce interpretations of evidence (Gopnik, 1996). They assert that these characteristics of scientific theories must also apply to children's understanding of the mind, if such understandings are truly theories of mind. That is, children's theories should involve appeal to abstract unobservable entities, with coherent relations among them. They should invoke characteristic explanations phrased in terms of these abstract entities

and laws. Children's theories should also lead to characteristic patterns of predictions, including predictions about new types of evidence and false predictions (Gopnik, 1993). Finally, children's theories should lead to distinctive interpretations of evidence. Gopnik and Wellman (1994) argue that children possessing one theory should interpret even the most fundamental facts and experiences differently than children possessing a different theory. Differing theories are the basis for differences among children at different points in development.

Proponents of the theory-theory approach believe that a number of different epistemological processes exist at the heart of theory change in science (Gopnik & Wellman, 1994). One particularly critical factor is the accumulation of counterevidence to a theory. However, the existence of counterevidence does not necessarily lead scientists to automatically reject a theory. The initial reaction of the theory to counterevidence may be to just deny the counterevidence, ignore it, or treat it as unworthy of attention (Gopnik, 1996). In addition, scientists may simply reinterpret the counterevidence to keep it consistent with the theory. At a slightly later stage, when science acknowledges that the counterevidence presents a problem for the theory, it may call on "ad hoc auxiliary hypotheses" designed

to specifically account for the counterevidence (Gopnik, 1996). Subsequent auxiliary hypotheses can undermine the coherence of an existing theory over time, making it splinter to the point where the theory no longer holds together. When this happens, an alternative model to the original theory must be created (Gopnik & Wellman, 1994). New conceptual structures may appear in the form of relatively small modifications of the existing theory. Only later may it become clear that new ideas also provide alternative explanations for the evidence that was central to the original theory (Gopnik & Wellman, 1994).

In terms of cognitive development in children, theory theorists argue that the most significant factor is also the accumulation of counterevidence (Gopnik & Wellman, 1994). Children may initially ignore certain kinds of counterevidence that contradicts their current theory or representation of the world. Theory theorists contend that children consistently misreport and misinterpret evidence when it conflicts with their theoretical preconceptions. Although the child's theory initially protects itself from counterevidence, the force of counterevidence eventually begins to push the theory in the direction of change (Gopnik, 1993). Children, like scientists, often account for certain kinds of counterevidence by developing auxiliary hypotheses (Gopnik

& Wellman, 1994). Furthermore, children might first use the new theoretical idea only in limited contexts that are closely related to the conceptual structure of their earlier theory. However, when their predictions continue to fail, theory change occurs. The availability or formulation of alternative models eventually occurs and the old theory is replaced by a new and better one, with the child generating new and different sets of predictions, interpretations, and explanations (Gopnik, 1993). Only after the theory change is complete will children ultimately reorganize their knowledge so that new theories play a central role.

Theory theorists point to particular cases, such as children's development of intuitive biology, physics, and psychology, in which their rules and representations seem to have the characteristics and follow the change process analogous to that of science (Gopnik, 1996). A key point of theory-theory is that development in these areas suggests that theory formation is specific to a particular domain. That is, a child's progress in one domain will be independent from their progress in others, with domains outside the scope of a target theory remaining unaffected by changes to that theory (Gopnik & Wellman, 1994). For example, Gopnik (1996) argues that there is no reason to expect the same underlying logical structures in a 5-year-

old's folk psychology and folk physics. Within a given domain of knowledge, there will be a substantial amount of stability and generality (Gopnik, 1996). Moreover, when conceptual changes take place, either through maturation or through theory formation, these changes affect a wide range of behaviors in a consistent way. All in all, the theory-theory approach considers young children to be much more sophisticated in their thinking than traditional developmental theories would have us believe.

In what serves as a challenge to the theory-theory approach, are findings from long-standing research programs focusing on children's and adults' understanding of memory, identity, and emotion (Gottfried, Gelman, & Schultz, 1999; Johnson, 1990; Johnson & Wellman, 1982; Winer, Cottrell, Bica, & Fournier, 1999). These studies question the assertion that development reflects cognitive restructuring representing a radical re-conceptualization of beliefs. Children's knowledge may not be as sophisticated as theory-theory approach suggests. Children's understandings or theories appear to be inconsistent across tasks, contexts or situations, with children showing a co-existence of scientific beliefs with more primitive, intuitive beliefs. Considerations of specific findings from these studies are in order.

Children's Understanding of Psychological Processes

Research by Johnson and Wellman (1982) examined children's concepts of mind in conjunction with their concepts of brain. Results suggested that during the elementary school years, children come to view the brain as the part of the body that guides action and interprets experience.

In the first study of a series of four, Johnson and Wellman (1982) asked kindergarten, third, and fifth grade students questions such as "Where is your brain?", "What does your brain do?", and "Do you need your brain to...?". The children were asked to explain their responses to approximately 20% of the items. The adult participants involved in the study were given a list of items and asked whether or not the brain was needed for each function (e.g., mental acts, feelings, senses, school tasks, simple motor movements, and involuntary movements).

Results of this first study indicated that almost every child referred to the head as the location of the brain and provided a reasonable explanation of what the brain does, usually mentioning its role in thinking. Significant age changes were noted in every case except mental acts. Mental acts (e.g., think, know, be smart) were consistently judged as needing the brain across all age groups. The brain was also typically judged to be needed for the school task

items (e.g., spell, count, read, tell a story), with even kindergartners performing significantly above chance level.

Judgments on the feeling items (e.g., curious, sad, scared, hungry) presented a mixed picture. Age differences were primarily due to a contrast between responses of kindergartners and adults. There were, however, different patterns of results within this category. Children of all ages tended to regard the brain as needed for feeling sure and curious, feelings associated with cognition. However, feeling hungry and sleepy, which tend to be associated with physical states, were less frequently linked with the brain among the children's groups. With regard to sensory-motor acts, as compared to kindergartners, older children more frequently argued that some cognitive processing was taking place and the brain was needed.

Johnson and Wellman found that up through fifth grade, children not only gave almost exclusively cognitive explanations of brain function, but also judged the brain to be generally unnecessary for involuntary responses (e.g., coughing, blinking, sleeping). They suggest that children may initially acquire a popular concept of the brain as distinctly cognitive, and later acquire a more technical understanding of the brain as essential for all behavior. Johnson and Wellman suspected that direct instruction in school was a

possible source of technical knowledge about the brain and did discover that a unit about the brain was a standard part of the fifth-grade science curriculum in their participants' school district. However, fifth graders that had received this training performed no differently on the judgment tasks than "uneducated" third and fifth graders. Johnson and Wellman suggest that children have difficulty coordinating their popular conception with new technical information.

In the second study, Johnson and Wellman compared judgments about the brain and mind. Children were asked to judge whether they could perform various acts without a brain/mind. First, third, fifth and ninth grade students were asked such questions as "Suppose you didn't have a brain/mind, could you still...?", "Where is your brain?", "Where is your mind?", "Are they (mind and brain) in the same or different places?", "Does your brain help your (body part)?", and "Does your (body part) help your brain?"

Results of this second study suggested that asking children what acts could be performed without the brain resulted in the same pattern of findings as asking whether a brain was needed. That is, younger children had a more restricted view of the brain as needed primarily for mental acts. Also,

young children identified the brain with the mind, both being associated with distinctly mental acts. During the school years, concepts of mind and brain do become increasingly differentiated. In addition, judgments about the relationship between one's brain and peripheral body parts confirmed that young children conceive of separated and dissociated body functions. They judged the brain and body parts as autonomous, whereas older subjects were more aware of interdependencies.

In the third study, Johnson and Wellman investigated children's ideas about the functions of the brain by exploring preschool children's judgments about mental acts (e.g., think, dream, remember), overt acts of the head (e.g., tell a story, tell a word), and overt peripheral acts (e.g., wiggle toes, walk). Three, four, and five-year-olds were asked such questions as "Do you need your brain to (type of act)?", "What does your brain do for (type of act)?", "What do you need to (type of act)?", and "Do you need your brain too?"

Results of study three suggested that mental acts were associated with the brain more than head and peripheral acts across all ages. Half of the 3-year-olds judged the brain to be implicated in at least 3 of the 4 mental acts. A majority of 4-year-olds and nearly all 5-year-olds responded at this level.

In study four, Johnson and Wellman explored three-, four- and five-year-olds' ability to differentiate the brain from the head. Forty-seven percent of 3-year-olds, 81% of 4-year-olds, and 100% of 5-year-olds located the brain in the head, suggesting that by no later than age 5 children do not confuse the brain with the external head.

One technique that researchers like Johnson have used to examine children's understanding of psychological processes is to ask about the consequences of hypothetically switching body parts with another individual. Philosophers have postulated that a brain transplant should lead to a transfer of mind and self (Popper & Eccles, 1977). In other words, if a scientist were to give a person a new brain, the mental contents of the new brain would be included.

In 1990, Johnson investigated developmental trends in children's ability to distinguish a person's subjective identity from their outward bodily characteristics by asking children about the consequences of transplants. Four studies were conducted, each based on a hypothetical transplant between the child participant and another character. Different body parts were proposed as transplants (e.g., brain, heart, mouth or face) to assess whether children associate changes in four categories (e.g., physical, cognitive, behavior, and

identity) with particular body parts. The transplant direction (e.g., from child participant to character or from character to child participant) was varied to investigate whether children more readily imagine the constancy of their own self than that of another. The type of character involved in the transplant (e.g., pig, human baby, or child of the same age and gender as the child participant) was also varied to assess whether categorical differences in identity, namely humanity and age, are more readily comprehended than individual differences in psychological characteristics and traits.

Overall, findings from these four studies demonstrate that school-age children are acquiring a comprehensive understanding that identity is located in the brain. Children distinguish hypothetical transplants of the brain as more central than transplants of the mouth, heart, or face for cognition, behavior, and identity. The studies also suggest that the early school years represent a transitional period of understanding for young children. For example, in the first study, where child participants were asked about imaginary brain transplants between themselves and a pig, first graders' understanding stood clearly between the very poor performance of kindergartners and the ceiling performance of second graders. However, in the second study, where child participants were asked about brain, mouth,

and heart transplants between themselves and a human baby, the performance of first graders was essentially equivalent to that of the third and fifth graders. Finally, in studies three and four, where participants were asked about brain, mouth, heart, or face transplants between themselves and a character of the same age and gender, first graders performed exceptionally poor to the point of confusion about the physical conditions of the tasks.

These findings prompted Johnson to argue that early identity judgments are highly susceptible to task conditions. Identity transformations may be more readily understood by young children when they are marked by clear category differences (e.g., age or humanity). The results suggest that during the elementary school years children are acquiring a firm understanding of the brain as the primary locus of psychological attributes and identity. The early school years, between the ages of 5 and 7, appear to be a transition phase, with performance being variable and subject to task conditions. While children this age readily imagined the consequences of transplants between themselves and another character of categorically different status (i.e., a pig or baby), they had great difficulty with proposed transplants between themselves and another child of the same status.

In a related series of studies, Gottfried, Gelman, and Schultz (1999) explored the path through which children develop an adult-like concept of the brain, known as the “brain-as-container” metaphor. In this conceptualization, the brain is thought of as similar to a filing cabinet that holds thoughts, ideas, and memories. Previous studies have suggested that preschool children recognize the brain is an important organ (Crider, 1981; Johnson & Wellman, 1982; Steward, Furuya, Steward, & Ikeda, 1982) and understand the cultural metaphor that the brain is the thinking center of the body. However, evidence from Johnson (1990) suggests that young children do not have an adult-like belief that a brain transplant would lead to changes in mental contents. Results from his studies indicate that this understanding does not develop until approximately second grade and that children between the ages of 4 and 8 do not conceptualize the brain as a container for thoughts and memories.

Gottfried, Gelman, and Schultz (1999) suggest a possible explanation for children’s failure to adopt the container metaphor. This particular metaphor competes with another early assumption that children hold about animals. Specifically, that category membership confers important, immutable properties. Children as young as 4 years of age will argue that

superficial physical changes such as changing an animal's "outsides" do not alter its identity or characteristic behaviors (Gelman & Wellman, 1991).

Gottfried, Gelman, and Schultz (1999) suggest that if children believe in an animal's essence as some abstract quality not reducible to or residing in any body part, then they should say that a brain transplant would not cause changes in thought. In order to adopt the container metaphor, children must believe that essence is house in the brain.

The series of experiments conducted by Gottfried, Gelman, and Schultz (1999) were designed to test whether young children see the brain as a container for thoughts and memories and whether they find it essential for mental activities such as thinking and remembering. Preschool, kindergarten, first-grade, and third-grade children heard stories describing transplants of either the brain or all the internal parts from one animal to another and were asked about the content of the animal's thoughts and memories both before and after the transplants. Results from these studies suggest that by the third grade, children know the brain-as-container metaphor because they indicate that a transplant of either brain or insides would lead to changes in an animal's thoughts and memories. Children in the first grade and younger did not generally conform to the brain-as-

container metaphor. These younger participants claimed the brain is important for mental activity, but does not contain thoughts or memories specifically. The researchers indicate that this developmental progression is consistent with Johnson (1990), who found similar understanding emerging around second grade.

Gottfried, Gelman, and Schultz suggest that the transplant task is difficult for young children because it requires them to consider competing conceptualizations of animals. On one hand, children recognize that specific organs are important for the animal (e.g., the brain is necessary for thinking and remembering). On the other hand, young children may possess an assumption that certain properties of animals, possibly including thoughts and memories, are conferred by category membership. The essence of the animal may be seen as an abstract quality that does not reside in the brain or even in the animal's insides. Gottfried, Gelman, and Schultz indicate that when presented with the brain transplant scenario, many young children answer in a way that suggests they view the brain more like a battery than like a container. Young children focus on category membership rather than the brain as the source of species-typical mental processes, suggesting that any brain is sufficient for producing species-typical thoughts and memories. For

these children, thoughts and memories are maintained over critical transformations such as brain or “insides” transplants, as it is maintained despite growth and other superficial changes (Gelman & Wellman, 1991).

In another set of related studies, Winer and colleagues (1999) have asked about the consequences of switching the brain versus the heart and other body parts on the localization of emotions, and have found that until about the fifth or sixth grade, love and other emotions are often localized in the heart as well as in the brain. These results are consistent with the observations of Johnson (1990) who showed that feelings and behaviors like kindness are localized in the heart more frequently than other aspects of identity or memory.

A recent study by Winer and colleagues (1999), investigated sixth graders’ and college students’ understanding about the location of love and memory by asking them about the consequences of switching hearts and brains on things that were loved, both animate and inanimate, or learned. The questions were presented both with and without an accompanying metaphor. For example, participants were presented with the following animate love vignette, “Henry loved his dog Spot (with all his heart) and John loved his dog Rover (with all his heart). Then Henry and John

switched (hearts/brains).” Then participants were asked, “What did each person love?” Inanimate love questions asked about loving things that were not alive (e.g., playing the violin). Memory vignettes included such items as “John learned the names of all the football players (by heart) and Henry learned the names of all the basketball players (by heart). Then each person switched (brains/hearts).” Researchers followed with the question, “What did each person remember?”

Results for heart-switch questions suggested a grade, domain and metaphor effect. The grade effect represented the developmental trend of children showing a greater tendency to assign functioning to the heart than adults. With regard to the domain effect, questions about animate loves produced fewer correct responses than inanimate loves and both of these conditions produced more errors than memory questions, which yielded nearly perfect performance for all ages. Finally, with regard to the metaphor effect, there were fewer correct responses with the metaphor questions (e.g., by heart or with all his heart) than non-metaphor questions.

Results for brain-switch questions indicated that there was no grade effect, but there was both a metaphor and domain effect. With regard to the

domain effect, only the animate-loving and memory items were significantly different from one another.

Findings from this study suggest that understanding emotion is more difficult than understanding cognitive processes like memory. In addition, children may not be as sophisticated as theory-theory suggests and metaphorical expressions can influence the understanding of psychological processes

All in all, the findings from studies of children's and adults' understanding of such psychological processes as memory, identity, and emotion pose serious considerations for the theory-theory approach to conceptualizing cognitive development. Specifically, results suggesting that separate belief systems may co-exist in the same individual, that beliefs may vary depending on context, and that certain incorrect beliefs may actually increase with age, are issues that must be addressed by theory-theory.

Hypotheses

Developmental trends in the understanding of such psychological processes as cognition, emotion, and personality are expected to unfold in the following manner:

1. Participant responses should demonstrate the same type of understanding about each psychological domain (cognition, emotion, or personality) and the central/peripheral items across conditions, regardless of question format.
2. There will be an overall trend from peripheral (heart, face, stomach, fingers, etc.) to central (brain) control of psychological processes with age. Younger participants will hold more peripheralist theories, older participants will hold more centralist theories.
3. Performance on central versus peripheral items within psychological domains will highlight developmental differences.
4. Participants will understand the central (brain) control of certain psychological processes (cognition) before that of other processes (emotion followed by personality).
5. By sixth grade (11-12 years of age), children's understanding of the central (brain) control of psychological processes will be equivalent to that of college students (18-22 years of age).

CHAPTER 3

METHODS

Participants

In order to examine developmental trends in the understanding of psychological processes, 404 participants representing four different age groups were included in the study.

The first two groups of participants consisted of 112 third grade students (51 males and 61 females) and 95 fifth grade students (43 males and 52 females) from Devonshire and Cedarwood Elementary Schools, public schools in the Columbus City School District located in central Ohio. The third group of participants consisted of 93 sixth grade students (36 males and 57 females) from Indianola Middle School, a public school in the Columbus City School District located in central Ohio. The fourth group consisted of 104 college students (51 males and 53 females) who participated in order to earn course credit in their introductory psychology classes offered at The Ohio State University, a public university located in central Ohio.

The participants ranged in age from 8 to 11 years (mean age = 8.91) for the third grade group, from 10 to 12 years (mean age = 10.74) for the fifth grade group, from 11 to 14 years (mean age = 11.92) for the sixth grade group, and from 17 to 47 years (mean age = 19.81) for the college group.

The elementary and middle schools have ethnically diverse student populations representing families of middle to low socioeconomic status. Cedarwood Elementary School's total enrollment was 483 students. Three-hundred and four students were Caucasian (62.9%), 172 students were African-American (35.6%), 3 students were Hispanic (.006%), and 4 students were Asian (.008%). Forty-four percent of Cedarwood's students qualified for free or reduced lunch. Devonshire Elementary School's total enrollment was 509 students. Two hundred and eighty eight students were African-American (56.6%), 216 students were Caucasian (42.4%), 1 student was Hispanic (.001%), and 4 students were Asian (.007%). Of the total student body, 51.9% qualified for free or reduced lunch. Indianola Middle School's total enrollment was 330 students. Two hundred and seventeen students were Caucasian (65.7%), 104 students were African-American (31.5%), 3 students were Hispanic (.009%), and 6 students were Asian (.018%). Of the total student body, 31.9% qualified for free or reduced lunch.

Participants were solicited by the researcher. College students participated to fulfill part of their course requirement for introductory psychology at The Ohio State University. Letters describing the nature of the study as well as parental consent forms were given to all participating teachers to distribute to the elementary and middle school students. See appendix A for copies of the parent information letter and consent form given to the elementary and middle school students. All participants participated on a voluntary basis and were free to withdraw their participation at any time during the interview.

Measures

The interview consisted of collecting demographic information and presenting participants with one of four possible test conditions: forced-choice questions, open-ended questions, brain switching questions or other body part switching questions. See appendix B for copies of the questions from each of the four different test conditions.

Demographic Information. The demographic questionnaire developed for this study contained questions regarding the following participant characteristics: gender, age, date of birth, and grade level for elementary and middle school students, and sex, age, date of birth, year in college, and major for college students.

Types of Test Questions. Participants were presented with one of the four possible test conditions described below.

Forced-Choice Questions

Participants in this condition were given the following information and instructions: “Medicines work in different areas of the body. In the next questions, you will be asked about where medicines work. Please give the best answer to each question.” Participants were then presented with 12 items designed to examine their understanding of the following three psychological domains: 4 questions for cognition (e.g., will remember how to play the piano better), 4 for emotion (e.g., fall in love with other people), and 4 for personality (e.g., make people mean and want to fight). Two of the 4 questions for each domain were designated as central items (psychological processes associated with the brain), while the other two were designated as peripheral items (psychological processes that have been linked to body parts other than the brain).

Each item was presented using the following format: “Imagine that a new pill was created to make people... Where would the medicine need to go in order for it to work?” Participants were asked to choose from four possible answers. The brain and heart were included as two of the four answer choices

for all items. Other choices included various parts of the body such as the stomach, face, fingers, and eyes. An example of a forced-choice question is as follows: “Imagine that a new pill was created to make people solve problems and riddles more quickly. Where would the medicine need to go in order for it to work? A person’s ... A. heart B. brain C. fingers D. eyes”

This condition also included 4 control items that asked where medicine would need to work in non-psychological situations (e.g., make skin rashes go away) involving other areas of the body than the brain. These items were included so that participants would consider the need for medicine to work in areas of the body other than the brain for certain situations.

A response was assigned a score of 1 if participants choose the correct answer (i.e., brain in the case of psychological processes and other areas of the body in the case of non-psychological processes) and a score of 0 if participants choose the incorrect answer (i.e., body parts in the case of psychological processes and the brain in the case of non-psychological processes).

Open-Ended Questions

Participants in this condition were given the following information and instructions: “Medicines work in different areas of the body. In the next questions, you will be asked about where medicines work.” Participants were

then presented with 12 items designed to examine their understanding of the same three psychological domains: 4 questions for cognition (e.g., will remember how to play the piano better), 4 for emotion (e.g., fall in love with other people), and 4 for personality (e.g., make people mean and want to fight). Two of the 4 questions for each domain were designated as central items (psychological processes associated with the brain), while the other two were designated as peripheral items (psychological processes that have been linked to body parts other than the brain). This condition also included 4 control items that asked where medicine would need to work in non-psychological situations (e.g., make skin rashes go away) involving areas of the body other than the brain.

Each item was presented using the following format: “Imagine that a new pill was created to make people... Where in the body would the medicine need to go in order for it to work? Why?” Participants were expected to indicate where the medicine should go and why it would work in that area of the body in order to achieve the intended results. An example of an open-ended question is as follows: “Imagine that a new pill was created to make people feel angry. Where would the medicine need to go in order for it to work? Why?”

Responses were assigned a score of 1 if participants discussed the correct answer (i.e., brain in the case of psychological processes and other areas of the

body in the case of non-psychological processes) and a score of 0 if participants discussed an incorrect answer (i.e., body parts in the case of psychological processes and the brain in the case of non-psychological processes). Responses were also coded to document the variety of areas of the body participants discussed in response to these items.

Brain Switching Questions

Participants in this condition were given the following information and instructions: “All the people in the situations that you will hear about live in a different world from ours. Their world is exactly like ours, except that people can change body parts with one another. Everyone’s body parts work just like they do in this world. You will be asked to answer some questions about what happens when they have some of their body parts switched. Please give the best answer to each question.” Participants were then presented with 12 items designed to examine their understanding of the consequences of switching brains on the three psychological domains, cognition, emotion, and personality (4 questions for each process). For example, a question involving cognition was “Billy remembers how to play the piano. Sean does not remember how to play the piano. Then Billy and Sean switched brains. Billy now has Sean’s brain. Sean has Billy’s brain. How well do Billy and Sean remember to play the

piano?” Participants were asked to determine whether the individuals in the questions will remain the same or change after the switch occurs. Two of the 4 questions for each domain were designated as central items (psychological processes associated with the brain), while the other two were designated as peripheral items (psychological processes that have been linked to body parts other than the brain). This condition also included 4 control items that asked about the consequences of switching brains or other body parts on non-psychological situations.

A response was assigned a score of 1 if participants chose the correct answer (i.e., change occurring following a brain switch and change occurring following a switch of other areas of the body in the case of non-psychological processes) and a score of 0 if participants chose the incorrect answer (i.e., change failing to occur following a brain switch or change not occurring when switching other body parts in the case of non-psychological processes).

Other Body Part Switching Questions

Participants in this condition were given the following information and instructions: “All the people in the situations that you will hear about live in a different world from ours. Their world is exactly like ours, except that people can change body parts with one another. Everyone’s body parts work just like

they do in this world. You will be asked to answer some questions about what happens when they have some of their body parts switched. Please give the best answer to each question.” Participants were then presented with 12 items designed to examine their understanding of the consequences of switching body parts other than the brain (i.e., faces, hearts, stomachs, fingers) on the three psychological domains, cognition, emotion, and personality (4 questions for each process). For example, a question involving personality was “Trent is mean and wants to fight. Bob is not mean and doesn’t want to fight. Then Trent and Bob switched hands. Trent now has Bob’s hands. Bob has Trent’s hands. What are Trent and Bob like?” Participants were asked to determine whether the individuals in the questions will remain the same or change after the switch occurs. Two of the 4 questions for each domain were designated as central items (psychological processes associated with the brain), while the other two were designated as peripheral items (psychological processes that have been linked to body parts other than the brain). This condition also included 4 control items that asked about the consequences of switching brains or other body parts on non-psychological situations.

A response was assigned a score of 1 if participants chose the correct answer (i.e., change not occurring when switching other body parts in the case of

psychological processes and change occurring following a switch of other areas of the body in the case of non-psychological processes) and a score of 0 if participants chose the incorrect answer (i.e., change taking place following the switching of other body parts in the case of psychological processes and change not occurring when switching other body parts in the case of non-psychological processes).

Procedure

The college students participating in the study were recruited from the introductory psychology program at The Ohio State University following the established procedures of the program. Elementary and middle school students were given a recruitment letter providing a brief description of the nature of the study, as well as instructions for attending the testing session. A letter to parent(s) requesting their signature to allow their child to participate in the study was sent home with each child. Students that received parental permission to participate in the study were interviewed one-on-one outside of their classroom (i.e., in the library) during regularly scheduled class time by the researcher or a member of the undergraduate research team. Students who were not permitted to participate in the study remained in their classroom and worked on other classroom assignments. The permission slips were collected by

the researcher and kept separate from each participant's responses in order to ensure anonymity.

All participants were told about their right to withdraw from the study at any time. Participants were provided with a brief description of the study following their participation and told about the confidentiality of their responses. Upon completing the interview, elementary and middle school students returned to their regular class assignments. The interviews took approximately fifteen minutes to complete per participant.

CHAPTER 4

RESULTS

The purpose of the current study was to investigate age trends in the understanding of the brain's central role in the control of cognition, emotion, and personality, as opposed to other peripheral structures of the body. The analyses that follow examine the major variables of the current study. Specifically, the central/peripheral variable will be examined to investigate differences in participants' responses to psychological processes associated with the brain as opposed to those often associated with parts of the body other than the brain. The psychological domain variable will also be examined in order to investigate participants' understanding of the three different domains, cognition, emotion, and personality.

The analyses will begin with an analysis of variance for major variables and the interactions of these variables across all test conditions. This analysis, which reveals many complex interactions, must be treated with caution because the study involved four different question formats that may have different psychometric properties. In order to understand the complex

interactions that emerged and to avoid some of the problems involved in dealing with different question formats, eventually each condition will be analyzed separately. First, however, we turn to the overall analysis.

Overall Analysis of Variance

Initially, a 4 (grade: 3rd, 5th, 6th and college) x 4 (condition: forced-choice, open-ended, brain switch, other body parts switch) x 2 (central vs. peripheral) x 3 (psychological domain: cognition, emotion and personality) repeated measures analysis of variance (ANOVA) was conducted, with repeated measures on the central/peripheral and psychological domain variables. The analysis was conducted on the number of correct responses to each question, where a correct response made reference to the brain as the locus of the psychological process asked about in the questions. There were four questions per psychological domain, 2 referring to central loci and 2 to peripheral, yielding a maximum score of 12. See table 1 for the overall analysis of variance results.

This analysis must be treated with caution since the question formats were different, and this difference may have artificially contributed to some of the differences. For instance, there were 4 answer choices for the forced-choice questions, 2 answer choices for the switching questions, and the open-

ended questions, naturally, had no choices offered. Thus, by chance alone, the highest number of correct responses would occur in the two-choice switching questions.

This complex analysis revealed highly significant effects for every variable and every combination of variables. Because of the complexity of the interactions and the inherent difficulty in comparing question formats, the data will be analyzed separately for each question format: forced-choice; open-ended; brain switch; and other body parts switch. Note that in preliminary analyses, gender never proved to be statistically significant or nearly statistically significant either when treated individually or within an interaction. Therefore, gender will not be included in the analyses presented for this study.

We will now proceed to separate analyses by question format. First, an examination of the analyses concerning responses to the forced-choice questions will be presented (I). In these questions, participants were asked about where medicine would need to go in order to effect certain processes. Next, an analysis of responses to the open-ended questions will be examined (II). In these questions, participants were again asked about where medicine would need to go in order to have an effect, but no answer choices were

given. An analysis of responses to the brain switch questions will be examined next (III). In these questions, participants were asked about the consequences of two people switching brains on certain processes. Finally, an examination of the analyses concerning other body part switch questions will be presented (IV). In these questions, participants were asked about the consequences of two people switching parts of the body other than the brain on certain processes.

Table 1

Analysis of Variance Results for Effects of Grade, Condition, Psychological Domain, and Central/Peripheral Items on Participant Responses

Variable	F	df	SS
Grade	54.28***	3	201.40
Condition	103.55***	3	73.77
Grade x Condition	32.63***	9	69.73
Central/Peripheral	262.80***	1	62.41
Grade x Central/Peripheral	9.26***	3	6.60
Condition x Central/Peripheral	16.87***	3	12.02
Grade x Condition x Central/Peripheral	2.72**	9	5.82
Psychological Domain	110.42***	2	52.44
Grade x Psychological Domain	8.10***	6	11.54
Condition x Psychological Domain	6.65***	6	9.47
Grade x Condition x Psychological Domain	1.69*	18	7.21
Central/Peripheral x Psychological Domain	59.48***	2	28.25
Grade x Central/Peripheral x Psychological Domain	2.35*	6	3.35
Condition x Central/Peripheral x Psychological Domain	6.45***	6	9.19
Grade x Condition x Central/Peripheral x Psychological Domain	2.33***	18	9.94

Note: *p<.05, **p<.01, ***p<.001

I. Examination of Responses to the Forced-Choice Questions

The first analysis concerns responses to the forced-choice questions. Recall that in these questions participants were asked about where medicine would have to go in order to effect certain changes. The four answer choices offered always included the brain and heart as options. Central items asked about such things as being smart, whereas peripheral items asked about such things as playing the piano. Also varied was the psychological domain. Questions were asked about cognition, such as solving problems and riddles, emotion, such as being happy and smiling all the time, and personality, such as wanting to meet new people.

In order to examine the effects of grade, central/peripheral, and psychological domain on participant responses to the forced-choice questions, a 4 (grade: 3rd, 5th, 6th and college) x 2 (central vs. peripheral) x 3 (psychological domain: cognition, emotion and personality) repeated measures analysis of variance (ANOVA) was conducted, with repeated measures on the central/peripheral and psychological domain variables. See table 2 for the results of this analysis.

The analysis revealed significant effects for every main variable and every interaction. A post hoc analysis of the grade effect revealed that the

college students ($M = 1.78$) performed significantly higher than the elementary students at each grade, and that among the children, the 5th graders had scores that were significantly higher ($M = 1.15$) than the 6th ($M = .82$) and 3rd graders ($M = .78$), whose scores were statistically indistinguishable. A post hoc analysis of psychological domain, yielded significant differences between all scores, with the highest score occurring for cognitive processes ($M = 1.40$), followed by personality ($M = 1.13$) and emotion ($M = .86$), respectively. An examination of the means for the central/peripheral variable showed that significantly higher scores emerged for central ($M = 1.37$) as opposed to peripheral ($M = .89$) items. However, these main effects were qualified by the significant triple interaction of grade, central/peripheral, and psychological domain. To understand this triple interaction, two separate sets of repeated measures ANOVAs were conducted.

Table 2

Analysis of Variance Results for Effects of Grade, Psychological Domain, and Central/Peripheral Items on Participant Responses to Forced-choice Questions (Condition 1)

Variable	F	df	SS
Grade	34.47***	3	100.29
Central/Peripheral	144.09***	1	36.32
Grade x Central/Peripheral	5.94***	3	4.49
Psychological Domain	59.23***	2	29.86
Grade x Psychological Domain	6.17***	6	9.33
Central/Peripheral x Psychological Domain	51.53***	2	25.98
Grade x Central/Peripheral x Psychological Domain	4.60***	6	6.95

Note: *p<.05, **p<.01, ***p<.001

A. Separate Analyses for Each Psychological Domain

In the first attempt to understand the triple interaction for grade, psychological domain, and central/peripheral questions, separate analyses for each psychological domain, cognition, emotion, and personality, were initially conducted. That is, for each of these three domains a 4 (grade: 3rd, 5th, 6th and college) $\times$ 2 (central vs. peripheral) repeated measures ANOVA, with repeated measures on the central/peripheral variable was conducted.

i. Analysis of Responses to Cognition Questions. The first analysis conducted on the cognition questions scores yielded a significant effect for grade, $F(3,99) = 15.29$, $p < .001$, and central/peripheral items, $F(1,99) = 211.77$, $p < .001$. However, a significant, two-way interaction between grade and central/peripheral, $F(3,99) = 12.67$, $p < .001$, qualified the outcomes on the grade and central/peripheral factors (see table 3).

In order to describe the differences between means, separate tables of means for within grade comparisons (see table 4) and between grade comparisons (see table 5) are presented. Table 4 shows the significant differences within each grade level between central and peripheral questions. Significant differences emerged between the central versus peripheral items for the 3rd, 5th, and 6th graders ($p < .001$) and college students ($p < .05$). That is,

there were significant effects at each grade level, with higher scores on the central than peripheral questions. Clearly, participants of all ages identified the brain as playing an important role in the central items significantly more often than in the peripheral items. Examination of the means in table 4 also reveals nearly ceiling effects for the central cognition questions at each grade level, with variations in the scores on peripheral questions.

Table 5 shows the significant differences between each grade level for central and peripheral questions. For cognition, significant differences emerged between each of three youngest age groups and college students ($p < .001$) on the peripheral items only. It is obvious from table 5 that the peripheral scores for the children in 3rd, 5th, and 6th grade were statistically indistinguishable, and significantly lower than the scores for the college students. Grade level differences were certainly highlighted by differences in participants' performance on the peripheral items.

In sum, the interaction for the cognition questions shows only a grade effect between children and adults on the peripheral items.

ii. Analysis of Responses to Emotion Questions. As was noted, a 4 (grade: 3rd, 5th, 6th and college) $\times$ 2 (central vs. peripheral) repeated measures ANOVA, with repeated measures on the central/peripheral variable, was

also conducted on responses to the emotion questions. The analysis revealed a significant effect for grade, $F(3,99) = 29.75, p < .001$, and a significant effect for the central/peripheral, $F(1,99) = 40.91, p < .001$, variable. An examination of the means revealed that there were higher scores among the central ($M = 1.08$) than peripheral items ($M = .64$). Post hoc analysis of the grade effect showed the highest scores for the college students ($M = 1.69$), the next highest scores among the 5th graders ($M = .92$), followed by the 6th ($M = .46$) and 3rd ($M = .38$) graders, respectively. There were significant differences between college students versus all other grade levels. Fifth graders performed significantly higher than 3rd and 6th graders, who scores were statistically indistinguishable. For the most part, these significant differences reflect a trend of increasing understanding of the role of the brain with increasing age. The fact that 5th graders outperformed 6th graders is most likely due to the overall low functioning of the particular 6th grade cohort that participated in the study.

For the purposes of comparing like scores, table 7 shows the means in the interaction between central/peripheral questions and grade for emotion questions within each grade level, and table 8 shows the means in the

interaction between central/peripheral questions and grade for emotion questions between grade levels

iii. Analysis of Responses to Personality Questions. As was the case in preceding analyses, a 4 (grade: 3rd, 5th, 6th and college) x 2 (central vs. peripheral) repeated measures ANOVA, with repeated measures on the central/peripheral variable, was conducted on responses to the emotion questions. The analysis revealed a significant effect for grade, $F(3,99) = 21.82$, $p < .001$. Post hoc analyses of the means (college, $M = 1.83$; 6th grade, $M = .78$; 5th grade, $M = 1.18$; 3rd grade, $M = .72$) revealed significant differences between college students versus all other grade levels. In addition, 5th graders performed significantly higher than 3rd and 6th graders, who had scores that were statistically indistinguishable. For the most part, these significant differences reflect a trend of increasing understanding of the role of the brain with increasing age. Again, the fact that 5th graders outperformed 6th graders can be attributed to the overall low functioning of this particular 6th grade cohort.

Again, for the purposes of comparing like scores, means for the interaction of central/peripheral questions and grade for personality questions are presented in table 10. Table 11 shows the means in the

interaction between central/peripheral questions and grade for personality questions between grade levels.

Up to this point, significant differences have been examined for the central and peripheral items across the three psychological domains. In sum, performance on central items is higher than performance on peripheral items at every level. Thus, we see that students understand the role of the brain more easily in the central items than they do in the peripheral items.

Table 3

Analysis of Variance Results for Effects of Grade and Central/Peripheral Items on Participant Responses to Forced-Choice Questions - Cognition (Condition 1)

Variable	F	df	SS
Grade	15.29***	3	12.05
Central/Peripheral	211.77***	1	52.56
Grade x Central/Peripheral	12.67***	3	9.43

Note: * $p < .05$, ** $p < .01$, *** $p < .001$

Table 4

Significant Differences Between Central and Peripheral Items Within Grades for Forced-Choice Questions - Cognition (Condition 1)

Grade	Items	
	Central	Peripheral
	Mean	Mean
3rd***	<u>1.76</u>	<u>.69</u>
5th***	<u>1.96</u>	<u>.76</u>
6th***	<u>1.96</u>	<u>.48</u>
College*	<u>1.96</u>	<u>1.65</u>

Note: * $p < .05$, ** $p < .01$, *** $p < .001$

Table 5

Significant Differences for Central and Peripheral Items Between Grades for Forced-Choice Questions - Cognition (Condition 1)

Items	Grade	
	3rd	5th
	Mean	Mean
Central	1.76	1.96
Peripheral	.69	.76
	3rd	6th
	Mean	Mean
Central	1.76	1.96
Peripheral	.69	.48
	3rd	College
	Mean	Mean
Central	1.76	1.96
Peripheral***	.69	1.65
	5th	6th
	Mean	Mean
Central	1.96	1.96
Peripheral	.76	.48
	5th	College
	Mean	Mean
Central	1.96	1.96
Peripheral***	.76	1.65
	6th	College
	Mean	Mean
Central	1.96	1.96
Peripheral***	.48	1.65

Note: *p<.05, **p<.01, ***p<.001

Table 6

Analysis of Variance Results for Effects of Grade and Central/Peripheral Items on Participant Responses to Forced-Choice Questions - Emotion (Condition 1)

Variable	F	df	SS
Grade	29.75***	3	57.09
Central/Peripheral	40.91***	1	9.73
Grade x Central/Peripheral	1.57	3	1.12

Note: * $p < .05$, ** $p < .01$, *** $p < .001$

Table 7

Significant Differences Between Central and Peripheral Items Within Grades for Forced-Choice Questions - Emotion (Condition 1)

Grade	Items	
	Central Mean	Peripheral Mean
3rd***	<u>.62</u>	<u>.14</u>
5th***	<u>1.24</u>	<u>.60</u>
6th**	<u>.65</u>	<u>.26</u>
College	1.81	1.58

Note: * $p < .05$, ** $p < .01$, *** $p < .001$

Table 8

Significant Differences for Central and Peripheral Items Between Grades for Forced-Choice Questions - Emotion (Condition 1)

Items	Grade	
	3rd	5th
	Mean	Mean
Central**	<u>.62</u>	<u>1.24</u>
Peripheral*	<u>.14</u>	<u>.60</u>
	3rd	6th
	Mean	Mean
Central	.62	.65
Peripheral	.14	.26
	3rd	College
	Mean	Mean
Central***	<u>.62</u>	<u>1.96</u>
Peripheral***	<u>.14</u>	<u>1.58</u>
	5th	6th
	Mean	Mean
Central**	<u>1.24</u>	<u>.65</u>
Peripheral	.60	.26
	5th	College
	Mean	Mean
Central**	<u>1.24</u>	<u>1.96</u>
Peripheral***	<u>.60</u>	<u>1.58</u>
	6th	College
	Mean	Mean
Central***	<u>.65</u>	<u>1.96</u>
Peripheral***	<u>.26</u>	<u>1.58</u>

Note: * $p < .05$, ** $p < .01$, *** $p < .001$

Table 9

Analysis of Variance Results for Effects of Grade and Central/Peripheral Items on Participant Responses to Forced-Choice Questions - Personality (Condition 1)

Variable	F	df	SS
Grade	21.82***	3	40.48
Central/Peripheral	.02	1	.00
Grade x Central/Peripheral	1.33	3	.89

Note: * $p < .05$, ** $p < .01$, *** $p < .001$

Table 10

Significant Differences Between Central and Peripheral Items Within Grades for Forced-Choice Questions - Personality (Condition 1)

Grade	Items	
	Central Mean	Peripheral Mean
3rd	.82	.62
5th	1.12	1.24
6th	.74	.83
College	1.85	1.81

Note: * $p < .05$, ** $p < .01$, *** $p < .001$

Table 11

Significant Differences for Central and Peripheral Items Between Grades for Forced-Choice Questions - Personality (Condition 1)

Items	Grade	
	3rd	5th
	Mean	Mean
Central	.82	1.12
Peripheral**	.62	1.24
	3rd	6th
	Mean	Mean
Central	.82	.74
Peripheral	.62	.83
	3rd	College
	Mean	Mean
Central***	.82	1.85
Peripheral***	.62	1.81
	5th	6th
	Mean	Mean
Central	1.12	.74
Peripheral	1.24	.83
	5th	College
	Mean	Mean
Central***	1.12	1.85
Peripheral**	1.24	1.81
	6th	College
	Mean	Mean
Central***	.74	1.85
Peripheral***	.83	1.81

Note: *p<.05, **p<.01, ***p<.001

B. Separate Analyses for Central and Peripheral Questions

The second attempt to understand the triple interaction for grade, psychological domain, and central/peripheral questions involved conducting separate analyses for central and for peripheral questions. That is, for both central questions and peripheral questions, a 4 (grade: 3rd, 5th, 6th and college) $\times$ 3 (psychological domain: cognition, emotion and personality) repeated measures ANOVA, with repeated measures on the psychological domain variable, was conducted. This analysis merely examines the same means as in the preceding analysis, but ordered differently.

i. Analysis of Responses to Central Items. The first analysis conducted on the scores for the central items yielded a significant effect for grade, $F(3,99) = 23.62, p < .001$, and psychological domain, $F(6,198) = 86.82, p < .001$. However, a significant two-way interaction emerged between grade and psychological domain, $F(6,198) = 8.36, p < .001$, that qualified the outcomes on the grade and psychological domain variables (see table 12). In order to understand this two-way interaction, means for within grade comparisons and between grade comparisons will be considered.

In terms of within grade differences, post hoc analyses revealed significant differences between cognition and both emotion and personality

for 3rd, 5th, and 6th graders on the central items (refer back to tables 4, 7, and 10 for means). That is, all three of the youngest age groups identified the brain as playing an important role in cognition significantly more often than emotion and personality. They did not distinguish, however, between the processes of emotion and personality. There were no significant differences among the domains for college students.

In terms of between grade comparisons for responses to the personality questions, post hoc analyses revealed that college students had significantly higher scores than 3rd, 5th, and 6th graders (refer back to tables 4, 7, and 10 for means). Among the children, 5th graders outperformed 6th graders on questions involving personality. For the emotion questions, post hoc analyses again revealed significantly higher scores for college students than all three of the younger grade levels. Among the children, 5th graders received significantly higher scores on emotion than both 3rd and 6th graders. Note that all participants' scores on the cognition questions were relatively high, thus, significant differences in cognition did not emerge for any grade level comparisons.

ii. Analysis of Responses to Peripheral Items. The second analysis conducted on the scores for the peripheral items also yielded a significant

effect for grade, $F(3,99) = 33.86, p < .001$, and psychological domain, $F(2,198) = 12.29, p < .001$. However, a significant two-way interaction also emerged between grade and psychological domain for peripheral items, $F(6,198) = 2.14, p < .05$, that qualified the outcomes on the grade and psychological domain variables (see table 13). In order to understand this two-way interaction, means for within grade comparisons and between grade comparisons will be considered.

In terms of within grade comparisons for cognition questions, 3rd graders had significantly higher scores on these than emotion questions (refer back to tables 4, 7, and 10 for means). Both 5th and 6th graders had significantly higher scores on personality questions than cognition questions. All three of the youngest grade levels had significantly higher scores on personality questions than emotion questions. There were no significant differences among the domains for college students.

In terms of between grade comparisons, college students outperformed all three younger grade levels on all three of the psychological domains (refer back to tables 4, 7, and 10 for means). This differs from the findings for the central items in which cognition scores were statistically indistinguishable for all grade levels. Given the greater difficulty younger participants had with

peripheral items, it is not surprising to see their scores differ, even on cognition questions, from that of adults. Among the children, 5th graders had significantly higher scores on both emotion and personality questions.

In sum, the interactions for the central and peripheral items showed a strong grade effect for the contrast in performance across the three psychological domains, particularly when it came to comparisons between children and adults. That is, comparisons revealed nearly ceiling effects for the central cognition questions, with gains across age. Participants' scores on peripheral cognition questions were lower. Performance on cognition questions was followed by lower scores on personality and emotion overall. For the most part, however, all significant differences considered in these analyses suggested a trend of increasing understanding of cognition, emotion, and personality with increasing age.

Table 12

Analysis of Variance Results for Effects of Grade and Psychological Domain on Participant Responses to Forced-choice Questions - Central (Condition 1)

Variable	F	df	SS
Grade	23.62***	3	32.34
Psychological Domain	86.82***	2	44.06
Grade x Psychological Domain	8.36***	6	12.73

Note: *p<.05, **p<.01, ***p<.001

Table 13

Analysis of Variance Results for Effects of Grade and Psychological Domain on Participant Responses to Forced-choice Questions - Peripheral (Condition 1)

Variable	F	df	SS
Grade	33.86***	3	72.44
Psychological Domain	12.29***	2	11.78
Grade x Psychological Domain	2.14*	6	3.55

Note: *p<.05, **p<.01, ***p<.001

II. Examination of Responses to Open-Ended Items

The preceding analyses (I) examined responses to the forced-choice questions, asking where medicine would have to go in order to influence certain processes. This next section examines responses to the open-ended questions. Similarly, participants were asked where medicine would have to go to effect and/or affect various processes, except here they were not presented with responses options. Instead, participants had to generate their answers.

In the analyses that follow, participants received a score of 1 if their responses mentioned the brain and a score of 0 if their responses indicated something else. Thus, although the structure of the open-ended questions differed from that of the forced-choice questions, the scoring was compatible. The same types of variable were included. That is, the questions varied as to whether they asked about more central versus more peripheral processing, and the questions varied as to the psychological domain involved (cognition, emotion, and personality).

In order to examine the effects of grade, central/peripheral, and psychological domain on participant responses to the open-ended questions of condition 2, a 4 (grade: 3rd, 5th, 6th and college) x 2 (central vs. peripheral)

x 3 (psychological domain: cognition, emotion and personality) repeated measures ANOVA was conducted, with repeated measures on the central/peripheral and psychological domain variables. See table 14 for the results of this analysis.

The analysis revealed significant effects for every main variable and for all the two-way interactions. A post hoc analysis of the grade effect revealed that the college students ($\underline{M} = 1.87$) performed significantly higher than the elementary students at each grade, and that among the children, the 6th graders had scores that were significantly higher ($\underline{M} = 1.50$) than the 5th graders ($\underline{M} = 1.15$), whose scores were significantly higher than the 3rd graders ($\underline{M} = .87$). A post hoc analysis for psychological domain yielded significant differences between all scores, with the highest score occurring for cognitive processes ($\underline{M} = 1.54$), followed by personality ($\underline{M} = 1.34$) and emotion ($\underline{M} = 1.16$), respectively. Examination of the means for the significant central/peripheral variable revealed, as expected, that the scores on the central items ($\underline{M} = 1.56$) were higher than those on the peripheral items ($\underline{M} = 1.13$). However, these main effects were qualified by the significant two-way interactions between grade and central/peripheral, $F(3,485) = 8.47, p < .001$, and grade and psychological domain, $F(6,485) = 3.14, p < .01$. These interactions

indicate that the participants' understanding of the central versus peripheral items, as well as their understanding of cognition, emotion and personality, differed as a function of grade level. What follows is an examination of these two-way interactions.

First, (A) the interaction between the central/peripheral variable and grade will be examined. Here, participants' responses to the central/peripheral items will be considered, both within and across grades. Then, (B) we will turn to an analysis of the interaction between psychological domain and grade. Here, participants' responses to the three psychological domains, both within and across grades, will be considered. Finally, (C) the interaction between psychological domain and the central/peripheral variable will be discussed briefly.

Table 14

Analysis of Variance Results for Effects of Grade, Psychological Domain, and Central/Peripheral Items on Participant Responses to Open-Ended Items (Condition 2)

Variable	F	df	SS
Grade	28.52***	3	88.90
Central/Peripheral	107.93***	1	28.27
Grade x Central/Peripheral	8.47***	3	6.66
Psychological Domain	28.53***	2	14.95
Grade x Psychological Domain	3.14**	6	4.94
Central/Peripheral x Psychological Domain	7.82***	2	4.10
Grade x Central/Peripheral x Psychological Domain	2.02	6	3.18

Note: *p<.05, **p<.01, ***p<.001

A. Analysis of the Interaction Between Grade and the Central/Peripheral Variable for Open-Ended Questions

i. Analysis of central/peripheral differences within each grade. First, participants' reactions to the central versus peripheral items were explored by examining the differences in their responses to each type of item, central and peripheral, within each grade level (see table 15). That is, central and peripheral items were first compared for the 3rd graders, then for 5th graders, 6th graders, and college students. Post hoc analyses revealed significant differences between the central and peripheral items for 3rd graders, 5th graders, and 6th graders. That is, for the open-ended questions, higher scores emerged for central than peripheral items. All three of the younger grade levels identified the brain as playing an important role in the central items significantly more often than in the peripheral items. There were no significant differences between college students' performance on the central versus peripheral items. As expected, college students performed close to ceiling level on both.

ii. Analysis of grade differences considered separately for the central and peripheral items. Grade level differences to the central and peripheral items were explored by comparing participants' performance on these items

across all grade levels. In terms of participant reactions to the central versus peripheral items across grade levels, significant differences emerged at each level of comparison (see table 15 for the means; table 16 presents significant differences). Post hoc analyses of the means (see table 16) revealed that on the peripheral items, the differences between all successive grades were significant. In this instance, there was a linear increase across grades. With higher grade, there were higher scores. Notice, that this same kind of effect did not occur in earlier analyses for the forced-choice questions (I), which sometimes showed that 6th graders performed at a lower level than 5th graders.

For the central items, the college students outperformed 3rd and 5th graders, and the 6th graders outperformed 3rd graders. Notice that when the differences for central and peripheral items are compared, they both reflect a trend of increasing understanding of the role of the brain with increasing age. Performance on both central and peripheral items increased as grade increased. However, there was more differentiation between grades for the peripheral items significance-wise than what appeared for the central items. This finding is not unexpected and is consistent with previous findings for the forced-choice questions (I). It is more difficult for participants to see the

role of the brain in peripheral items than in central items. As expected, the peripheral items serve to contrast the abilities of the different grade levels.

Table 15

Significant Differences Between Central and Peripheral Items Within Grades for Open-Ended Questions (Condition 2)

Grade	Items	
	Central	Peripheral
	Mean	Mean
3rd***	<u>1.19</u>	<u>.55</u>
5th***	<u>1.44</u>	<u>.86</u>
6th***	<u>1.70</u>	<u>1.30</u>
College	1.92	1.81
<u>Note: *p<.05, **p<.01, ***p<.001</u>		

Table 16

Significant Differences for Central and Peripheral Items Between Grades for Open-Ended Questions (Condition 2)

Items	Grade	
	3rd Mean	5th Mean
Central	1.19	1.44
Peripheral*	<u>.55</u>	<u>.86</u>
	3rd Mean	6th Mean
Central**	<u>1.19</u>	<u>1.70</u>
Peripheral***	<u>.55</u>	<u>1.30</u>
	3rd Mean	College Mean
Central***	<u>1.19</u>	<u>1.92</u>
Peripheral***	<u>.55</u>	<u>1.81</u>
	5th Mean	6th Mean
Central	1.44	1.70
Peripheral**	<u>.86</u>	<u>1.30</u>
	5th Mean	College Mean
Central**	<u>1.44</u>	<u>1.92</u>
Peripheral***	<u>.86</u>	<u>1.81</u>
	6th Mean	College Mean
Central	1.70	1.92
Peripheral**	<u>1.30</u>	<u>1.81</u>

Note: *p<.05, **p<.01, ***p<.001

B. Analysis of the Interaction Between Grade and Psychological Domain for Open-Ended Questions

The second two-way interaction to be discussed is that between grade and psychological domain.

i. Separate comparisons for each of the three domains within each grade. As mentioned previously, participants' responses to the three psychological domains, cognition, emotion, and personality, are to be examined both within and across grades. First, differences in participants' responses within each grade level will be discussed (see table 17).

Post hoc analyses revealed that for 3rd graders there were significant differences between the cognition ($\underline{M} = 1.14$) items and both the emotion ($\underline{M} = .68$) and personality ($\underline{M} = .79$) items. For 5th graders, the same pattern occurred: scores on cognition ($\underline{M} = 1.44$) items were higher than scores on both emotion ($\underline{M} = .94$) and personality ($\underline{M} = 1.08$) items, with no difference between the last two scores.

A slightly different pattern emerged for 6th graders, with scores on both cognition ($\underline{M} = 1.70$) and personality ($\underline{M} = 1.61$) items higher than those for emotion ($\underline{M} = 1.20$) items. For college students, there was again high performance and no significant differences among the scores.

These comparisons reveal that 3rd and 5th graders identify the brain as playing an important role in cognition significantly more often than emotion and personality. However, 3rd and 5th graders fail to demonstrate any significant difference in their understanding of emotion and personality. At the 6th grade level, a change occurs that differentiates the 6th graders' responses from those of 3rd and 5th graders. Sixth graders understand the role of the brain in cognition significantly more often than emotion just as the younger participants do, however, they perform as well on items involving personality as those involving cognition. It appears as though by the 6th grade, children understand the role of the brain in personality as well as its role in cognition. Their responses differentiate questions involving personality from those involving emotion. The 6th graders demonstrated a greater knowledge of the brain's role in personality, a distinction not present in the younger grade levels. As expected, college students, had scores close to ceiling level on items across all three domains.

ii. Separate grade comparisons for each of the three domains. Analysis of the participants' reactions to each of the three psychological domains across grade levels, revealed a trend of increasing understanding of cognition, emotion, and personality with increasing age (see table 18). Post hoc analyses

revealed that, on the cognition items, 3rd graders had significantly lower scores than 6th graders and college students, and 5th graders had significantly lower scores than college students.

For the emotion items, college students scored higher than children in all three grade levels. Among the children, 6th graders had higher scores than 3rd graders. For the personality items, college students and 6th graders had significantly higher scores than 3rd and 5th graders.

In summary, it is important to note that all significant comparisons across grades suggest a trend of increasing understanding of cognition, emotion, and personality with increasing age. Overall, the highest performance was consistently seen with cognition questions, followed by personality and emotion, respectively. The differences that do exist, moreover, make sense. The fewest number of grade differences emerged for the cognition items; more emerged for personality and for emotion. As questions across domains become more difficult, with the cognitive domain the least difficult, the personality domain of intermediate difficulty, and the emotion domain the most difficult, there were increasingly more significant differences between grades. Note that the difficulty referred to is understanding the role of the brain in different psychological processes.

Table 17

Significant Differences for Psychological Domain Within Grades for Open-Ended Questions (Condition 2)

Grade	Psychological Domain	
	Cognition	Emotion
	Mean	Mean
3rd***	<u>1.14</u>	<u>.68</u>
	Cognition	Personality
3rd***	<u>1.14</u>	<u>.79</u>
	Emotion	Personality
3rd	<u>.68</u>	<u>.79</u>
	Cognition	Emotion
	Mean	Mean
5th***	<u>1.44</u>	<u>.94</u>
	Cognition	Personality
5th***	<u>1.44</u>	<u>1.08</u>
	Emotion	Personality
5th	<u>.94</u>	<u>1.08</u>
	Cognition	Emotion
	Mean	Mean
6th***	<u>1.70</u>	<u>1.20</u>
	Cognition	Personality
6th	<u>1.70</u>	<u>1.61</u>
	Emotion	Personality
6th***	<u>1.20</u>	<u>1.61</u>
	Cognition	Emotion
	Mean	Mean
College	<u>1.90</u>	<u>1.83</u>
	Cognition	Personality
College	<u>1.90</u>	<u>1.87</u>
	Emotion	Personality
College	<u>1.83</u>	<u>1.87</u>

Note: *p<.05, **p<.01, ***p<.001

Table 18

Significant Differences for Psychological Domain Between Grades for Open-Ended Questions (Condition 2)

Psychological Domain	Grade	
	3rd	5th
	Mean	Mean
Cognition	1.14	1.44
Emotion	.68	.94
Personality	.79	1.08
	3rd	6th
	Mean	Mean
Cognition**	1.14	1.70
Emotion**	.68	1.20
Personality***	.79	1.61
	3rd	College
	Mean	Mean
Cognition***	1.14	1.90
Emotion***	.68	1.83
Personality***	.79	1.87
	5th	6th
	Mean	Mean
Cognition	1.44	1.70
Emotion	.94	1.20
Personality**	1.08	1.61
	5th	College
	Mean	Mean
Cognition*	1.44	1.90
Emotion***	.94	1.83
Personality***	1.08	1.87
	6th	College
	Mean	Mean
Cognition	1.70	1.90
Emotion**	1.20	1.83
Personality	1.61	1.87

Note: * $p < .05$, ** $p < .01$, *** $p < .001$

C. Analysis of the Interaction between Psychological Domain and the Central/Peripheral Variable. Given the current study's focus on effects across different grade levels, the interaction between psychological domain and the central/peripheral variable for the open-ended questions is not perhaps of as much interest as previously discussed interactions. Nonetheless, this interaction was found to be significant, $F(2,485) = 7.82, p < .001$, and will be discussed briefly here.

Examination of the means reveals that, as expected, the highest mean was for the central cognitive ($M = 1.85$) items, and, consistent with the other findings reported, the lowest mean was for the peripheral emotion ($M = .92$) items (see table 19). In fact, the means for this interaction are very consistent with previously reported findings. Higher scores emerged for central items across the three domains than peripheral items, with cognition questions receiving higher scores than personality and emotion questions, respectively.

Table 19

Means for the Interaction of Psychological Domain and Central/Peripheral
Items for Open-Ended Questions (Condition 2)

Psychological Domain	Items	
	Central	Peripheral
	Mean	Mean
Cognition	1.87	1.24
Emotion	1.40	.92
Personality	1.44	1.23

III. Examination of Responses to Brain Switch Questions

The first analysis (I) examined responses to forced-choice questions that asked about the impact of medicines. The second (II) analysis examined responses to open-ended questions also asking about the impact of medicines. In the analyses to be reported in this section, questions identified as “brain switch,” or those questions asking participants whether switching brains of two people would influence psychological processes, are examined. As in the preceding analyses, the content of the questions varied, in some instances asking about central as opposed to peripheral processes. Also varied were domains of content, so that some questions asked about cognition, others about emotion, and others about personality. As in the preceding analyses, a score of 1 was assigned to responses indicating that the brain switch mattered. A score of 0 was assigned to responses indicating the brain switch had no effect on psychological processes.

In order to examine the effects of grade, central/peripheral, and psychological domain on participant responses to the brain switch questions of condition 3, a 4 (grade: 3rd, 5th, 6th and college) × 2 (central vs. peripheral) × 3 (psychological domain: cognition, emotion and personality) repeated

measures ANOVA was conducted, with repeated measures on the central/peripheral and psychological domain variables (see table 20).

The analysis revealed significant effects for every main variable except grade and for the two-way interaction between psychological domain and the central/peripheral variable. Examination of the means for the grade factor revealed high scores at every grade: college students ($\underline{M}$ = 1.78), 6th ($\underline{M}$ = 1.47), 5th ($\underline{M}$ = 1.58), and 3rd graders ($\underline{M}$ = 1.65). These findings are not surprising, given the importance that even very young children place on the brain.

For the central/peripheral variable, examination of the means reveals, as might be expected, higher scores for the central ($\underline{M}$ = 1.70) than peripheral ($\underline{M}$ = 1.54) items. The fact that participants attributed the brain to central items significantly more often than peripheral items is consistent with the findings for previous analyses (I and II). Once again, differences have been highlighted in participants' responses to central versus peripheral items. For the purposes of comparing like scores, table 21 shows the means in the interaction between central/peripheral items and grade within each grade level.

A post hoc analysis for the significant psychological domain effect yielded significant differences among all scores, with the highest score occurring for the cognitive processes ($\underline{M} = 1.74$), followed by personality ($\underline{M} = 1.62$) and emotion ($\underline{M} = 1.50$), respectively (see table 22). These significant differences suggest that, across all grades, subjects understand the central (brain) control cognition first, followed by personality and emotion, respectively. For the purposes of comparing like scores, table 23 shows the means in the interaction between grade and psychological domain within each grade level.

Means for the significant interaction between psychological domain and the central/peripheral variable are presented in table 24. As before, the table reveals the highest scores for the central cognitive questions ($\underline{M} = 1.86$) and the lowest scores for the peripheral emotion questions ($\underline{M} = 1.38$).

Table 20

Analysis of Variance Results for Effects of Grade, Psychological Domain, and Central/Peripheral Items on Participant Responses to Brain Switch Questions (Condition 3)

Variable	F	df	SS
Grade	1.86	3	7.30
Central/Peripheral	16.44***	1	3.50
Grade x Central/Peripheral	1.61	3	1.03
Psychological Domain	13.58***	2	5.78
Grade x Psychological Domain	.81	6	1.04
Central/Peripheral x Psychological Domain	5.81**	2	2.47
Grade x Central/Peripheral x Psychological Domain	.63	6	.81

Note: *p<.05, **p<.01, ***p<.001

Table 21

Significant Differences Between Central and Peripheral Items Within Grades for Brain Switch Questions (Condition 3)

Grade	Items	
	Central	Peripheral
	Mean	Mean
3rd*	<u>1.73</u>	<u>1.58</u>
5th*	<u>1.65</u>	<u>1.50</u>
6th***	<u>1.61</u>	<u>1.33</u>
College	1.79	1.76
<u>Note: *p<.05, **p<.01, ***p<.001</u>		

Table 22

Significant Differences of Psychological Domain Across all Grades for Brain Switch Questions (Condition 3)

	Psychological Domain	
	Cognition	Emotion
	Mean	Mean
Across all Grades***	<u>1.74</u>	<u>1.50</u>
	Cognition	Personality
	Mean	Mean
	Mean	Mean
Across all Grades**	<u>1.74</u>	<u>1.62</u>
	Emotion	Personality
	Mean	Mean
	Mean	Mean
Across all Grades**	<u>1.50</u>	<u>1.62</u>
Note: *p<.05, **p<.01, ***p<.001		

Table 23

Significant Differences of Psychological Domain Within Grades for Brain Switch Questions (Condition 3)

Grade	Psychological Domain	
	Cognition	Emotion
	Mean	Mean
3rd**	<u>1.75</u>	<u>1.50</u>
3rd	Cognition	Personality
	1.75	1.71
3rd**	Emotion	Personality
	<u>1.50</u>	<u>1.71</u>
	Cognition	Emotion
	Mean	Mean
5th	1.67	1.50
5th	Cognition	Personality
	1.67	1.56
5th	Emotion	Personality
	1.50	1.56
	Cognition	Emotion
	Mean	Mean
6th***	<u>1.67</u>	<u>1.30</u>
6th**	Cognition	Personality
	<u>1.67</u>	<u>1.43</u>
6th	Emotion	Personality
	1.30	1.43
	Cognition	Emotion
	Mean	Mean
College	1.87	1.69
College	Cognition	Personality
	1.87	1.77
College	Emotion	Personality
	1.69	1.77

Note: *p<.05, **p<.01, ***p<.001

Table 24

Means for the Interaction of Psychological Domain and Central/Peripheral Items for Brain Switch Questions (Condition 3)

Psychological Domain	Items	
	Central	Peripheral
	Mean	Mean
Cognition	1.86	1.62
Emotion	1.62	1.38
Personality	1.61	1.63

IV. Examination of Responses to Other Body Part Switch Questions

In the analyses to be reported in this final section, questions identified as “other body part switch,” or those questions asking participants whether switching body parts other than brains of two people would influence psychological processes, are examined. As in all preceding analyses (I, II, and III), psychological domains varied, so that some questions asked about cognition, others about emotion, and others about personality. Within these domains, just as in previous analyses, some questions asked about central as opposed to peripheral processes. A score of 1 was assigned to responses indicating that the body part switch did not have an effect on psychological processes. A score of 0 was assigned to responses indicating the body part switch had an effect.

In order to examine the effects of grade, central/peripheral, and psychological domain on participant responses to the other body part switch questions of condition 4, a 4 (grade: 3rd, 5th, 6th and college) x 2 (central vs. peripheral) x 3 (psychological domain: cognition, emotion and personality) repeated measures ANOVA was conducted, with repeated measures on the central/peripheral and psychological domain variables. See table 25 for the results of this analysis.

The analysis revealed significant effects for every main variable and the two-way interactions between grade and psychological domain and between psychological domain and the central/peripheral variable. Examination of the means revealed significantly higher scores for central items ($\underline{M} = 1.43$) than peripheral items ($\underline{M} = 1.21$). This significant difference suggests that participants know that other body parts are less involved for the central than peripheral processes. Even though the interaction between grade and the central/peripheral variable was not significant, table 26 shows the means in the interaction between grade and central/peripheral items within each grade level for the purposes of comparing like scores across analyses.

A post hoc analysis of the grade effect revealed that college students ($\underline{M} = 1.81$) performed significantly higher than elementary students at each grade, and that among the children, the 3rd graders had scores that were significantly lower ($\underline{M} = .85$) than the 5th ($\underline{M} = 1.36$) and 6th graders ($\underline{M} = 1.26$), whose scores were statistically indistinguishable. A post hoc analysis for psychological domain revealed that cognitive processes ($\underline{M} = 1.39$) and personality ($\underline{M} = 1.45$) were statistically indistinguishable, but significantly higher scores emerged for personality than for emotion ($\underline{M} = 1.12$).

Given that these main effects were qualified by the significant two-way interactions, an examination of these interactions will follow. First, the significant interaction between grade and psychological domain will be considered, both within and across grades. Then, the significant interaction between psychological domain and the central/peripheral variable will be briefly discussed.

Table 25

Analysis of Variance Results for Effects of Grade, Psychological Domain, and Central/Peripheral Items on Participant Responses to Other Body Part Switch Questions (Condition 4)

Variable	F	df	SS
Grade	15.09***	3	74.32
Central/Peripheral	30.83***	1	6.86
Grade x Central/Peripheral	.42	3	.28
Psychological Domain	26.23***	2	11.67
Grade x Psychological Domain	2.58**	6	3.44
Central/Peripheral x Psychological Domain	11.62***	2	5.17
Grade x Central/Peripheral x Psychological Domain	1.78	6	2.38

Note: *p<.05, **p<.01, ***p<.001

Table 26

Significant Differences Between Central and Peripheral Items Within Grades for Other Body Part Switch Questions (Condition 4)

Grade	Items	
	Central	Peripheral
	Mean	Mean
3rd***	<u>.99</u>	<u>.72</u>
5th*	<u>1.44</u>	<u>1.27</u>
6th*	<u>1.35</u>	<u>1.17</u>
College***	<u>1.94</u>	<u>1.69</u>
<u>Note: *p<.05, **p<.01, ***p<.001</u>		

A. Analysis of the Interaction Between Psychological Domain and Grade for Other Body Part Switch Questions

Given that the main effect of domain was qualified by the significant two-way interaction between grade and psychological domain, $F(6,475) = 2.58$, $p < .001$, an examination of the three psychological domains was explored by examining the differences in participant responses both within and across each grade level.

i. Separate comparisons for each of the three domains within each grade. Post hoc analyses revealed the same pattern of significant differences for the three youngest grade levels and a slightly different pattern of significant differences for college students (see table 27). When 3rd, 5th, and 6th graders had to decide whether switching a part of the body other than the brain would affect a psychological process, all three of the youngest grade levels performed significantly better on items involving cognition and personality than those involving emotion. These three grade levels failed to demonstrate any significant difference in their understanding of cognition and personality. At the college level, participants performed significantly better on items involving personality than those involving both cognition

and emotion, but did not distinguish between items involving cognition and emotion.

ii. Separate grade comparisons for each of the three domains. Post hoc analyses of means revealed that college students performed significantly higher on cognition questions ($\underline{M} = 1.73$) than 3rd graders ($\underline{M} = 1.02$). See table 28 for significant differences in means across grades. For personality questions, 3rd graders received significantly lower scores ($\underline{M} = .93$) than college students ($\underline{M} = 1.96$), 6th graders ($\underline{M} = 1.42$), and 5th graders ($\underline{M} = 1.48$). College students also outperformed 6th graders on this domain. For emotion questions, college students ($\underline{M} = 1.75$) performed significantly higher than 3rd ($\underline{M} = .61$), 5th ($\underline{M} = 1.09$), and 6th graders ($\underline{M} = 1.04$).

Overall, significant differences were found to exist between each grade comparison, with the exception of 5th and 6th grade. At these grade levels, scores for the three domains were statistically indistinguishable. It is important to note that the greatest differences between grades emerged for the personality and emotion scores. As with previous question formats, differences in cognition scores were less frequent. For the other body part switch questions, the only significant difference for cognition emerged between 3rd graders and college students, who had significant differences for

all three domains. All in all, these significant differences all reflect a trend of increasing understanding of cognition, emotion, and personality with increasing age.

B. Analysis of the Interaction between Psychological Domain and the Central/Peripheral Variable. Means for the significant interaction between psychological domain and the central/peripheral variable are presented in table 29. As before, the table reveals the highest scores for the central cognitive questions ($\underline{M} = 1.58$) and the lowest scores for the peripheral emotion questions ($\underline{M} = .97$).

Table 27

Significant Differences of Psychological Domain Within Grades for Other Body Part Switch Questions (Condition 4)

Grade	Psychological Domain	
	Cognition	Emotion
	Mean	Mean
3rd***	<u>1.02</u>	<u>.61</u>
	Cognition	Personality
3rd	1.02	.93
	Emotion	Personality
3rd***	<u>.61</u>	<u>.93</u>
	Cognition	Emotion
	Mean	Mean
5th***	<u>1.50</u>	<u>1.09</u>
	Cognition	Personality
5th	1.50	1.48
	Emotion	Personality
5th***	<u>1.09</u>	<u>1.48</u>
	Cognition	Emotion
	Mean	Mean
6th**	<u>1.31</u>	<u>1.04</u>
	Cognition	Personality
6th	1.31	1.42
	Emotion	Personality
6th***	<u>1.04</u>	<u>1.42</u>
	Cognition	Emotion
	Mean	Mean
College	1.73	1.75
	Cognition	Personality
College**	<u>1.73</u>	<u>1.96</u>
	Emotion	Personality
College*	<u>1.75</u>	<u>1.96</u>

Note: *p<.05, **p<.01, ***p<.001

Table 28

Significant Differences of Psychological Domain Between Grades for Other Body Part Switch Questions (Condition 4)

Psychological Domain	Grade	
	3rd	5th
	Mean	Mean
Cognition	1.02	1.50
Emotion	.61	1.09
Personality*	.93	1.48
	3rd	6th
	Mean	Mean
Cognition	1.02	1.31
Emotion	.61	1.04
Personality*	.93	1.42
	3rd	College
	Mean	Mean
Cognition**	1.02	1.73
Emotion***	.61	1.75
Personality***	.93	1.96
	5th	6th
	Mean	Mean
Cognition	1.50	1.31
Emotion	1.09	1.04
Personality	1.48	1.42
	5th	College
	Mean	Mean
Cognition	1.50	1.73
Emotion**	1.09	1.75
Personality	1.48	1.96
	6th	College
	Mean	Mean
Cognition	1.31	1.73
Emotion**	1.04	1.75
Personality*	1.42	1.96

Note: *p<.05, **p<.01, ***p<.001

Table 29

Means for the Interaction of Psychological Domain and Central/Peripheral Items for Other Body Part Switch Questions (Condition 4)

Psychological Domain	Items	
	Central	Peripheral
	Mean	Mean
Cognition	1.58	1.20
Emotion	1.28	.97
Personality	1.42	1.47

CHAPTER 5

DISCUSSION

The current study investigated age trends in the understanding of the brain's central role in the processes of cognition, emotion, and personality, as opposed to other peripheral structures of the body. Four different questions formats were used in the study, forced-choice, open-ended, brain switch, and other body part switch. Major variables of the study included the central/peripheral factor, or differences in participants' responses to psychological processes associated with the brain as opposed to other parts of the body, and the psychological domain variable, or participants' understanding of the three different domains, cognition, emotion, and personality.

Question Format

Hypothesis I of the present study postulated that participants should demonstrate the same type of understanding about each psychological domain (cognition, emotion, or personality) and central/peripheral processing across question types (i.e., regardless of question format: open-

ended, forced-choice, brain switch or other body part switch). This hypothesis was generated from the theory-theory approach, which asserts that within a given domain of knowledge, there will be a substantial amount of stability and generality (Gopnik, 1996). When conceptual changes do take place, either through maturation or through theory formation, these changes affect a wide range of behaviors in a consistent way. With this in mind, it seemed reasonable to hypothesize that children's knowledge in any of the three domains investigated in this study should be consistent across context and question format.

Findings from other long-standing research programs (Gottfried, Gelman, & Schultz, 1999; Johnson, 1990; Johnson & Wellman, 1982; Winer, Cottrell, Bica, & Fournier, 1999), however, question the assertion that children's knowledge is as consistent and sophisticated as the theory-theory approach suggests. Research findings that run counter to theory-theory suggest that children's understandings or theories are inconsistent across tasks, contexts or situations, with children showing a co-existence of scientific beliefs with more primitive, intuitive beliefs.

Upon testing hypothesis I, significant differences emerged in participants' responses to the four question formats. Participants received the

highest scores on the brain switch questions, followed by the open-ended questions, other body part switch questions, and forced-choice questions, respectively. These differences may be due to the psychometric or other properties of the different test questions. For example, the fact that some questions offer two choices presents a greater opportunity for correct responses by chance alone than those that offer four choices. But this simple explanation does not suffice, because in two cases the number of choices offered was the same, namely two choices, and responses did vary.

Another issue related these differences could be responses to closed versus open-ended test questions in general. Some researchers have argued that open-ended, self-report measures underestimate children's cognitive abilities. For instance, the conclusion that young children do not tend to think about people in terms of psychological characteristics has been based on verbally demanding, free-description studies that may underestimate their ability (Miller & Aloise, 1989). These researchers suggest that studies utilizing less verbally demanding forced-choice questions may yield different conclusions.

This explanation also does not suffice when it comes to understanding the differences in participant responses across question formats. The open-

ended questions used in the current study did not appear to be verbally demanding, nor did they produce difficulties in articulation, given the fact that participants received higher scores on these items than both the 4-option forced-choice and the 2-option other body part switch questions. The fact that participants performed quite well on the open-ended questions is compatible with many methodological studies investigating the closed versus open-ended question controversy. Findings from these studies suggest that open-ended questions do accurately capture participants' ability, typically with greater reliability and validity than closed questions (Converse, 1984; Geer, 1988).

What the results of the current study suggest is that as children first develop a theory about the functioning of the brain, they are correct in their understanding that the brain is important and responsible for a variety of processes, as shown in the high scores for the brain switch questions, but their theories are not complete. Young children may not understand the fully psychological nature of the processes of cognition, emotion, and personality in the sense that they are unable to resist suggestions of the importance of body parts other than the brain that are embedded in some questions. Children appear to believe that psychological processes may also

reside and take place inside the body as well as or instead of in the brain. It is likely, therefore, that hypothesis I was not supported because children's theories about a given psychological domain are, in fact, inconsistent across tasks.

Responses to the Central and Peripheral Items

Hypothesis II postulated that there would be an overall trend from peripheral (heart, face, stomach, fingers, etc.) to central (brain) control of psychological processes with age. That is, younger participants would hold more peripheralist theories, while older participants would hold more centralist theories. Hypothesis III postulated that performance on central versus peripheral items within psychological domains would highlight developmental differences. These hypotheses are based on previous work, such as studies by Winer and colleagues (1999) that asked about the consequences of switching the brain versus the heart and other body parts on the localization of emotions. Findings suggested that until about the 5th or 6th grade, love and other emotions are often localized in the heart as well as in the brain. These results are consistent with the observations of Johnson (1990) who showed that feelings and behaviors like kindness are localized in the heart more frequently than other aspects of identity or memory.

Central and peripheral items within grades. An examination of participants' responses to the central versus peripheral items within each grade level revealed significant differences for 3rd, 5th, and 6th graders across all four question types. Regardless of question format, the three youngest grade levels all performed significantly higher on the central items than the peripheral items. These trends suggest that the three youngest age groups identify the brain as playing an important role in the central items significantly more often than the peripheral items. For instance, participants readily identified the brain as the most important body part for helping individuals solve problems and riddles more quickly, but were less certain about the brain's role when it came to remembering how to play the piano (cognition). Although participants thought the brain played an important role in helping people stick to a project without having to be told to finish it, they were less certain about the role of the brain in making people mean and want to fight (personality).

Interestingly, significant differences also emerged between college students' performance on central versus peripheral items for the forced-choice and other body part switch questions. Although these findings were rather unexpected, consideration of the question formats for these two

conditions, as well as an examination of the participants' explanations of their responses, help to shed some light onto these findings. First, we will consider the question formats. With the forced-choice questions, participants were given a choice among four parts of the body, with the brain always presented as one of the choices. For the other body part switch questions, the emphasis of the questions was on switching body parts other than the brain. Thus, in both of these conditions, unlike the open-ended and brain switch questions, body parts other than or in addition to the brain were made salient to the participants.

Second, an examination of the college students' rationales for their responses reveals certain patterns of thinking about the peripheral items for these question formats that made them rather problematic. For one, many of the college students seemed possibly to demonstrate metaphorical thinking about these items. When asked where medicine would need to go in order to make people fall in love, college students that chose the heart stated rationales such as "Because that's where your feelings are and I associate the heart with love." When asked about two people switching hearts, students indicated that these individuals "would feel different things if they had different hearts." Students that thought switching hands would make a

difference in one's performance in art and drawing stated that the good artist must have had "an artistic hand." One can question, however, as to whether people were just thinking metaphorically or not. That is, was their interpretation such that they viewed the heart "as if" or "like" it were the repository of love and emotion or did they really think that love was truly located in the heart. Further research might explore this question by specifically asking people, "Do you really think that love is located in the heart?"

In addition to what might be metaphorical thinking, rationales stated by college students also seemed to demonstrate a focus on peripheral parts of the body that would be associated with the experience of a particular psychological process. For example, when asked where medicine would need to go to make a person nervous and upset, students that chose the stomach stated, "I guess when you're nervous, it can upset your stomach" and "you can always feel it in your gut when you're nervous." Participants that thought switching hands would change one's performance in art and drawing stated that "hands are one of the main reasons they're good with art - they're good with their hands" and "maybe her hand was more stable."

Finally, the college students' rationales for their peripheral answers also seemed to reflect attempts to integrate technical information they had acquired about the brain and body from coursework or other sources. At times, their answers appeared to reflect their knowledge of the interdependence of the brain and other parts of the body. For example, when asked where medicine would need to go to make people happy and smiling, one college student that chose the face said, "Because people smiling all the time are most generally happier. That's based on a study I heard about in Psychology 100." Several students indicating that the fingers played a central role in remembering how to play the piano better reported hearing about the importance of "muscle memory."

Central and peripheral items across grades. An examination of participants' responses to the central versus peripheral items between grade levels also supported the age trends proposed by hypotheses II and III across all but one of the question formats. Significant differences emerged between grades for the forced-choice, open-ended, and other body part switch questions. The greatest differences were found between the two youngest age groups, 3rd and 5th graders, and college students, with college students

performing significantly higher on both central and peripheral items across the majority of comparisons.

Comparisons among the other grade levels suggest that both 5th and 6th graders have a significantly higher level of understanding than 3rd graders. In addition, college students are performing at a significantly higher level than 6th graders, although differences are not as striking as those between college students and 3rd and 5th graders. With only a couple of exceptions, 5th and 6th graders performed at the same level, showing little difference in their understanding.

When examining these comparisons, it is important to note that although differences in performance often occurred for both central and peripheral items between grades, it was the peripheral items that emerged to highlight differences in many cases. Overall, trends observed in these comparisons between grade levels appear to support the hypotheses that there would be shift in focus from peripheral to central control of psychological processes with age and that performance on central versus peripheral items would highlight developmental differences.

In contrast to the forced-choice, open-ended, and other body part switch questions, significant differences in performance did not emerge

between grade levels for the brain switch questions. These findings are not surprising, given previous studies suggesting that even preschool children recognize the brain is an important organ of the body (Crider, 1981; Johnson & Wellman, 1982; Steward, Furuya, Steward, & Ikeda, 1982). Participants of all ages seemed to believe that switching brains would have an effect on all of the psychological processes presented to them in the scenarios of this condition.

Understanding of Psychological Domains

Hypothesis IV of the present study postulated that participants will understand the role of the brain in cognitive processes before emotion and personality, respectively. This hypothesis was based on numerous studies in the areas of research investigating children's understanding of cognition, emotion, and personality.

Cognition. With regard to cognition, Miller and Aloise (1989) argue that preschool children have a rudimentary understanding of information-processing activities. Young children's first conception of the brain is that of an organ of intellectual function (Johnson & Wellman, 1982). Their metacognitive understanding of brain functions, although limited, first surrounds the processes of memory and attention (Miller & Aloise, 1989). In

studies investigating children's understanding of the necessity of the brain, Johnson and Wellman (1982) found all age groups included (kindergarten, 3rd and 5th graders, and adults) to consistently judge the brain as necessary for mental acts such as thinking, knowing, remembering and being smart. Studies by Gottfried, Gelman, and Schultz (1999) indicate that by third grade, children uniformly claim that thoughts and memories are localized in the brain and do not see other (non-brain) internal parts as the locus for these processes. Eight year olds appear to have a specific concept of memory (Fabricius et. al., 1989) and, up through grade 5, children give almost exclusively cognitive explanations of brain function (Johnson & Wellman, 1982). This host of findings suggests that an understanding of the brain's role in cognitive processes is present, at least in rudimentary form, from a very early age.

Emotion. Findings from Winer et al. (1999) suggest that understanding emotion is more difficult than understanding cognitive processes like memory. Although the understanding of cognitive processes does seem to appear at a young age, studies investigating children's understanding of emotion suggest that even preschoolers have some knowledge of the causes of emotion (Russell, 1990). Preschool children also

have some understanding of the consequences of different emotions and can differentiate causes from consequences. Harris and Olthof (1982) argue, however, that young children simply conceive of emotions as a stimulus-response event and that it is not until later in childhood that they have a firm understanding that mental states of the brain mediate between the situation and the emotional response. This transition to a mentalistic concept of emotion has been found to occur prior to 6 years of age (Gove & Keating, 1979). Harris, Olthof, and Terwogt (1981) suggest that four year olds may understand that cognitive processes can control emotion. Other studies have suggested that children as young as four years of age were able to recognize effective cognitive emotion control strategies (Brown, Covell, & Abramovitch, 1991). By the 3rd grade, the majority of children indicate that the brain is needed for feelings such as being sure, curious, sad, and scared (Johnson, 1990) and children readily attribute behavior to individual's emotional states (Miller & Aloise, 1989).

Personality. In contrast to findings regarding children's understanding of cognition and emotion, researchers investigating personality find that dispositions and the constancy of traits is not fully understood by young children, and that dispositional attributions are uncommon in early

childhood (Miller & Aloise, 1989). Young children seem to conceptualize people in terms of their group memberships, appearance, overt behavior, and other “superficial” nondispositional factors rather than their stable personality traits (Shantz, 1983). Results of this research have been consistent in suggesting that children younger than about 8 years of age rarely use stable, dispositional constructs in their descriptions of others (Rholes & Ruble, 1984). Rholes and Ruble (1984) argue that this knowledge is not well established until the later years of middle childhood, stating that even five to seven year olds do not think that an actor’s traits will predict his behavior in related situations.

The ages of seven and eight seem to represent a transition period with respect to the dispositional concept, or children’s acquisition of a stable view of dispositions (Livesley & Bromley, 1973; Rholes, Jones, and Wade, 1988). These are also the ages at which children show a dramatic shift in the use of personality trait terms in their descriptions of others (Barenboim, 1981; Livesley & Bromley, 1973). Children between nine and ten years of age expect substantial cross-situational stability in behavior and understand that behavior is caused by personal factors (Rholes & Ruble, 1984). How then did the participants in this study perform?

Understanding of each specific psychological domain within grades.

The hypothesis regarding the sequential understanding of cognition, emotion, and personality was partially supported with regard to participants' knowledge of the role of the brain in cognitive processes. An examination of participants' reactions to the three psychological domains within each grade level revealed the highest scores for cognition in almost every comparison across all four question formats. The only exceptions to this pattern occurred in 5th and 6th graders responses to the forced-choice peripheral items, and college students responses to the other body part switch questions. In all three instances, participants received significantly higher scores for personality than for cognition. The cause of these unusual deviations from the overall trend is unknown.

Hypothesis IV was not supported with regard to participants' performance on the emotion versus personality domain. In every significant comparison that emerged between these two domains within every grade level, scores for personality were higher than those for emotion. This finding runs counter to the proposed hypothesis that participants would understand the role of the brain in emotion before personality.

The items that comprised the personality domain were designed after McCrae and Costa's (1987) five-factor model of personality. Specifically, the four items were written to illustrate the personality dimensions of extraversion-introversion, neuroticism-stability, conscientiousness-undirectedness, and agreeableness-antagonism.

One possible explanation for participants' higher scores on the personality domain is that these items may have emphasized somewhat "cognitive" aspects of personality more so than the emotion questions. As Johnson (1990) indicates, young children define the brain in terms of "thinking" and realize its importance for mental acts. An examination of participants' rationales for their responses suggests that many focused on the "cognitive" processes involved in the personality questions, such as attention and memory. For example, subjects commented that "the brain helps you hold your attention span" with regard to sticking to a project (conscientiousness). When asked about wanting to meet new people (extraversion), one participant commented, "That's how you think to talk and people think about their thoughts before they talk." When asked about being mean and wanting to fight (antagonism), another participant stated, "The brain because that's where you remember things that make you mad,

like when you fight with someone, you get mad first.” It is very likely that the wording of the personality questions prompted participants to identify with the cognitive aspects of the scenarios.

Understanding of each specific psychological domain across grades.

Separate examinations of participants’ understandings of each of the three psychological domains across grade levels revealed significant differences between grades for the forced-choice, open-ended, and other body part switch questions. Significant differences in understanding did not emerge between grade levels for the brain switch questions. Once again, these findings are not surprising given the fact that all participants seemed to believe that switching brains would have an effect on all of the psychological processes presented to them in the scenarios of this condition.

In every significant comparison that emerged, with the exception of 5th and 6th graders for the forced-choice questions, scores on all three domains increased with age. Again, the greatest contrasts were found between the two youngest age groups, 3rd and 5th graders, and college students. It is important to note that, except for comparisons in which two grade levels performed significantly differently in all three domains, participants’ understanding of cognition was statistically indistinguishable.

This finding supports the hypothesis that participants would have a firm understanding of the brain's role in cognition before emotion and personality.

Similar to the pattern of findings for the central/peripheral variable, college students performed at a significantly higher level than 6th graders across question formats. It was hypothesized that by 6th grade, children's understanding of the central (brain) control of psychological processes would be equivalent to that of college students. This hypothesis was based on previous work, such as that of Winer and colleagues (1999), that suggests a developmental shift in understanding occurs between the 5th and 6th grade. Winer finds that until about the 5th or 6th grade, love and other emotions are often localized in the heart as well as in the brain. This hypothesis was not supported in the current study. One possible explanation for the findings that the 6th graders did not perform at the same level as the adults, is the fact that the 6th graders participating in this study may have been exceptionally low functioning. During data collection, one of the teachers mentioned that the 6th graders at the participating middle school seemed to be much lower in academic ability than other 6th graders she had worked with in the past. In fact, results of the Ohio sixth-grade proficiency tests did indicate that the

6th graders involved in the study performed considerably below average (see appendix C). Additional studies are needed to investigate whether other samples of 6th grade students might perform at or near adult levels on these tasks.

Summary

The purpose of the current study was to contribute to the knowledge base on children's understanding of the role of the brain in a variety of psychological processes. There are multiple reasons for examining whether psychological processes are localized in the brain as opposed to other parts of the body. For one, the understanding that the brain is the location of identity, emotion, cognition, and personality is a core piece of Western folk psychology that children in our society eventually acquire. The ability to pinpoint approximate ages when this understanding occurs contributes to our knowledge of children's theory of mind. In addition, traditional theory of mind researchers have argued that the young child's mental understanding is relatively sophisticated and consistent within given domains. Findings from the current study, however, suggest a much less complete understanding of psychological processes. That is, although young children use terms referring to cognition, emotion, and personality in

appropriate contexts, they may not completely understand the fully psychological nature of these processes.

The current study contributes to the existing literature because it investigates children's understanding across three different psychological domains, as well as the notion that certain processes within these domains may be regarded as more central and others more peripheral. While other researchers have explored the localization of cognition and some emotions, the current study expands upon previous work by including a variety of emotions and personality traits. In addition, whereas previous studies have examined what children know about the role of the brain, they have not always investigated children's notions about the role that other body parts play in psychological processes. As other studies indicate, children may very well know that the brain is involved and/or realize the importance of the brain for mental activities, but these studies have not always given children an opportunity to talk about other body parts that they believe are involved and may be even more important than the brain. Findings from Johnson (1990) suggest that by five years of age, all children locate the brain in the head, thus, children should not think that the brain is located in another part of the body like the heart, stomach, eyes, etc. However, children in the

current study certainly localized a variety of psychological activities in parts of the body other than the brain.

Findings from the current study strongly suggest that children may believe the brain is not the only place where thoughts, memories, emotions, and personality traits are stored. In other words, they may have a container metaphor that is not localized in the brain. Children appear to believe that psychological processes reside and take place inside the body as well as or instead of in the brain. Additional studies are needed to further investigate children's knowledge of how the brain's actions differ from those of other body parts in the control of these psychological processes.

APPENDIX A
SAMPLE PARENT LETTER AND CONSENT FORM

May 4, 2000

Dear Parent/Guardian,

My name is Lori Bica and I am a graduate student in developmental psychology at The Ohio State University. My adviser, Dr. Jerry Winer, and I are working on a project to investigate children's understanding of psychological processes and we are very interested in getting input from the students of Cedarwood Elementary School. I will be conducting a study at Cedarwood on **Friday, May 12**, and am writing to request your child's participation.

The students will be asked a short set of questions regarding their understanding of the processes of cognition, personality and emotion. The questions will be administered in a one-on-one interview during class and will take no more than fifteen minutes to complete.

Your child's responses will be kept strictly confidential. In addition, your child is free to withdraw from participating in the study at any time. No audiotaping or videotaping will take place and your child's school records will not be accessed. The decision to allow or not allow your child to participate will not affect him/her at school in any way.

If you have any questions or would like further information about the study, please feel free to contact me at (614) 785-1163 or my adviser, Dr. Jerry Winer, at (614) 292-3041. If you decide that you **do not** want your child to participate in the study, please sign the attached form and have your child return it to his/her classroom teacher on or before Friday, May 12.

Thank you,

Lori A. Bica, M.A.
Graduate Student
Department of Psychology

I have read the information concerning the purpose of and participation in the Ohio State University project.

I **do not** want my child to participate in the project.

Student's Name

Parent/Guardian Signature

Date

APPENDIX B

**TEST CONDITIONS: FORCED CHOICE, OPEN-ENDED, BRAIN SWITCH
AND OTHER BODY PART SWITCH QUESTIONS**

CONDITION 1 • FORCED CHOICE QUESTIONS

“Medicines work in different areas of the body. In the next questions, you will be asked about where medicines work. Please give the best answer to each question.”

1. Imagine that a new pill was created to make people solve problems and riddles more quickly. Where would the medicine need to go in order for it to work? A person's ...
- A. heart
 - B. brain
 - C. fingers
 - D. eyes

Why? _____

2. Imagine that a new pill was created to make people feel angry. Where would the medicine need to go in order for it to work? A person's ...
- A. eyes
 - B. heart
 - C. muscles
 - D. brain

Why? _____

3. Imagine that a new pill was created to make people good at art and drawing. Where would the medicine need to go in order for it to work? A person's ...
- A. brain
 - B. hands
 - C. eyes
 - D. heart

Why? _____

4. Imagine that a new pill was created to make people's hair grow faster. Where would the medicine need to go in order for it to work? A person's ...
- A. heart
 - B. muscles
 - C. brain
 - D. hair

5. Imagine that a new pill was created to make people fall in love with other people. Where would the medicine need to go in order for it to work? A person's ...
- A. brain
 - B. eyes
 - C. heart
 - D. face

Why? _____

6. Imagine that a new pill was created to make people happy and smiling. Where would the medicine need to go in order for it to work? A person's ...
A. mouth
B. brain
C. heart
D. face
7. Imagine that a new pill was created to make people able to stick to a project without having to be told to finish it. Where would the medicine need to go in order for it to work? A person's ...
A. hands
B. eyes
C. heart
D. brain
8. Imagine that a new pill was created to make people's paper cuts on their fingers heal faster. Where would the medicine need to go in order for it to work? A person's ...
A. heart
B. brain
C. fingers
D. stomach

Why?

9. Imagine that a new pill was created to make people mean and want to fight. Where would the medicine need to go in order for it to work? A person's ...
A. legs
B. brain
C. hands
D. heart
10. Imagine that a new pill was created to make people remember how to play the piano better. Where would the medicine need to go in order for it to work? A person's ...
A. heart
B. eyes
C. fingers
D. brain
11. Imagine that a new pill was created to make people's skin rashes go away. Where would the medicine need to go in order for it to work? A person's ...
A. skin
B. heart
C. brain

D. eyes
Why? _____

12. Imagine that a new pill was created to make people want to meet new people and talk all the time. Where would the medicine need to go in order for it to work? A person's ...
A. brain
B. eyes
C. mouth
D. heart

Why? _____

13. Imagine that a new pill was created to make people have stronger teeth. Where would the medicine need to go in order for it to work? A person's ...
A. heart
B. teeth
C. brain
D. fingers

14. Imagine that a new pill was created to make people feel worried. Where would the medicine need to go in order for it to work? A person's ...
A. stomach
B. heart
C. brain
D. eyes

15. Imagine that a new pill was created to make people smarter. Where would the medicine need to go in order for it to work? A person's ...
A. heart
B. eyes
C. brain
D. hands

16. Imagine that a new pill was created to make people nervous and upset. Where would the medicine need to go in order for it to work? A person's ...
A. brain
B. stomach
C. face
D. heart

Why? _____

CONDITION 2 • OPEN-ENDED QUESTIONS

“Medicines work in different areas of the body. In the next questions, you will be asked about where medicines work. Please give the best answer to each question.”

1. Imagine that a new pill was created to make people solve problems and riddles more quickly. Where would the medicine need to go in order for it to work? Why?
2. Imagine that a new pill was created to make people feel angry. Where would the medicine need to go in order for it to work? Why?
3. Imagine that a new pill was created to make people good at art and drawing. Where would the medicine need to go in order for it to work? Why?
4. Imagine that a new pill was created to make people’s hair grow faster. Where would the medicine need to go in order for it to work? Why?
5. Imagine that a new pill was created to make people fall in love with other people. Where would the medicine need to go in order for it to work? Why?
6. Imagine that a new pill was created to make people happy and smiling. Where would the medicine need to go in order for it to work? Why?
7. Imagine that a new pill was created to make people able to stick to a project without having to be told to finish it. Where would the medicine need to go in order for it to work? Why?
8. Imagine that a new pill was created to make people’s paper cuts on their fingers heal faster. Where would the medicine need to go in order for it to work? Why?
9. Imagine that a new pill was created to make people mean and want to fight. Where would the medicine need to go in order for it to work? Why?
10. Imagine that a new pill was created to make people remember how to play the piano better. Where would the medicine need to go in order for it to work? Why?
11. Imagine that a new pill was created to make people’s skin rashes go away. Where would the medicine need to go in order for it to work? Why?
12. Imagine that a new pill was created to make people want to meet new people and talk all the time. Where would the medicine need to go in order for it to work? Why?

13. Imagine that a new pill was created to make people have stronger teeth. Where would the medicine need to go in order for it to work? Why?
14. Imagine that a new pill was created to make people feel worried. Where would the medicine need to go in order for it to work? Why?
15. Imagine that a new pill was created to make people smarter. Where would the medicine need to go in order for it to work? Why?
16. Imagine that a new pill was created to make people nervous and upset. Where would the medicine need to go in order for it to work? Why?

CONDITION 3 • BRAIN SWITCH QUESTIONS

"All of the people in the situations you will hear about live in a different world from ours. Their world is exactly like ours, except that people can change body parts with one another. But everyone's body parts work just like they do in this world. You will be asked to answer some questions about what happens when they have some of their body parts switched. Please give the best answer to each question."

1. Jenny solves problems and riddles quickly. Samantha doesn't solve problems and riddles quickly. Then Jenny and Samantha switched brains. Jenny now has Samantha's brain. Samantha has Jenny's brain. What are Jenny and Samantha like?
- A. Jenny still solves problems and riddles quickly and Samantha doesn't solve problems and riddles quickly.
 - B. Now Jenny doesn't solve problems and riddles quickly and Samantha solves problems and riddles quickly.

Why? _____

2. Billy feels angry. Sean doesn't feel angry. Then Billy and Sean switched brains. Billy now has Sean's brain. Sean has Billy's brain. What are Billy and Sean like?
- A. Billy still feels angry and Sean doesn't feel angry.
 - B. Now Billy doesn't feel angry and Sean feels angry.

Why? _____

3. Christine is good at art and drawing. Betty is not good at art and drawing. Then Christine and Betty switched brains. Christine now has Betty's brain. Betty has Christine's brain. What are Christine and Betty like?
- A. Christine is still good at art and drawing and Betty is not good at art and drawing.
 - B. Now Christine is not good at art and drawing and Betty is good at art and drawing.

Why? _____

4. Jill's hair grows fast. Lori's hair does not grow fast. Then Jill and Lori switched brains. Jill now has Lori's brain. Lori has Jill's brain. What are Jill and Lori like?
- A. Jill's hair still grows fast and Lori's hair does not grow fast.
 - B. Now Jill's hair does not grow fast and Lori's hair grows fast.

5. Jeremy easily falls in love with other people. Joe does not easily fall in love with other people. Then Jeremy and Joe switched brains. Jeremy now has Joe's brain. Joe has Jeremy's brain. What are Jeremy and Joe like?
- A. Jeremy still falls in love with other people easily and Joe does not fall in love with other people easily.
 - B. Now Jeremy does not fall in love with other people easily and Joe falls in love with other people easily.

Why? _____

6. Ben is happy and smiling. Chris is not happy and smiling. Then Ben and Chris switched brains. Ben now has Chris' brain. Chris has Ben's brain. What are Ben and Chris like?
- A. Ben is still happy and smiling and Chris is not happy and smiling.
 - B. Now Ben is not happy and smiling and Chris is happy and smiling.
7. Alice is able to stick to a project without having to be told to finish it. Amy is not able to stick to a project without having to be told to finish it. Then Alice and Amy switched brains. Alice now has Amy's brain. Amy has Alice's brain. What are Alice and Amy like?
- A. Alice is still able to stick to a project without having to be told to finish it and Amy is not able to stick to a project without having to be told to finish it.
 - B. Now Alice is not able to stick to a project without having to be told to finish it and Amy is able to stick to a project without having to be told to finish it.
8. Kim's paper cuts on her fingers heal fast. Mary's paper cuts on her fingers don't heal fast. Then Kim and Mary switched brains. Kim now has Mary's brain. Mary has Kim's brain. What are Kim and Mary like?
- A. Kim's paper cuts on her fingers still heal fast and Mary's paper cuts on her fingers don't heal fast.
 - B. Now Kim's paper cuts on her fingers don't heal fast and Mary's paper cuts on her fingers heal fast.

Why? _____

9. Trent is mean and wants to fight. Bob is not mean and doesn't want to fight. Then Trent and Bob switched brains. Trent now has Bob's brain. Bob has Trent's brain. What are Trent and Bob like?
- A. Trent is still mean and wants to fight and Bob is not mean and doesn't want to fight.
 - B. Now Trent is not mean and doesn't want to fight and Bob is mean and wants to fight.
10. Lynn remembers how to play the piano. Helen does not remember how to play the piano. Then Lynn and Helen switched brains. Lynn now has Helen's brain. Helen has Lynn's brain. What are Lynn and Helen like?
- A. Lynn still remembers how to play the piano and Helen does not remember how to play the piano.
 - B. Now Lynn does not remember how to play the piano and Helen remembers how to play the piano.

11. Tom's skin rashes go away quickly. Ronny's skin rashes do not go away quickly. Then Tom and Ronny switched brains. Tom now has Ronny's brain. Ronny has Tom's brain. What are Tom and Ronny like?
- A. Tom's skin rashes still go away quickly and Ronny's skin rashes do not go away quickly.
 - B. Now Tom's skin rashes do not go away quickly and Ronny's skin rashes go away quickly.

Why? _____

12. Melissa wants to meet new people and talk all the time. Julie does not want to meet new people and talk all the time. Then Melissa and Julie switched brains. Melissa now has Julie's brain. Julie has Melissa's brain. What are Melissa and Julie like?
- A. Melissa still wants to meet new people and talk all the time and Julie does not want to meet new people and talk all the time.
 - B. Now Melissa doesn't want to meet new people and talk all the time and Julie wants to meet new people and talk all the time.

Why? _____

13. Stephanie has strong teeth. Judy does not have strong teeth. Then Stephanie and Judy switched brains. Stephanie now has Judy's brain. Judy has Stephanie's brain. What are Stephanie and Judy like?
- A. Stephanie still has strong teeth and Judy does not have strong teeth.
 - B. Now Stephanie does not have strong teeth and Judy has strong teeth.

14. Jack feels worried. Mike does not feel worried. Then Jack and Mike switched brains. Jack now has Mike's brain. Mike has Jack's brain. What are Jack and Mike like?
- A. Jack still feels worried and Mike does not feel worried.
 - B. Now Jack does not feel worried and Mike feels worried.

15. Marie is smart. Connie is not very smart. Then Marie and Connie switched brains. Marie now has Connie's brain. Connie has Marie's brain. What are Marie and Connie like?
- A. Marie is still smart and Connie is not very smart.
 - B. Now Marie is not very smart and Connie is smart.

16. Alex is nervous and upset. Travis is not nervous and upset. Then Alex and Travis switched brains. Alex now has Travis' brain. Travis has Alex's brain. What are Alex and Travis like?
- A. Alex is still nervous and upset and Travis is not nervous and upset.
 - B. Now Alex is not nervous and upset and Travis is nervous and upset.

Why? _____

CONDITION 4 • OTHER BODY PART SWITCH QUESTIONS

"All of the people in the situations you will hear about live in a different world from ours. Their world is exactly like ours, except that people can change body parts with one another. But everyone's body parts work just like they do in this world. You will be asked to answer some questions about what happens when they have some of their body parts switched. Please give the best answer to each question."

1. Jenny solves problems and riddles quickly. Samantha doesn't solve problems and riddles quickly. Then Jenny and Samantha switched fingers. Jenny now has Samantha's fingers. Samantha has Jenny's fingers. What are Jenny and Samantha like?

- A. Jenny still solves problems and riddles quickly and Samantha doesn't solve problems and riddles quickly.
B. Now Jenny doesn't solve problems and riddles quickly and Samantha solves problems and riddles quickly.

Why? _____

2. Billy feels angry. Sean doesn't feel angry. Then Billy and Sean switched hearts. Billy now has Sean's heart. Sean has Billy's heart. What are Billy and Sean like?

- A. Billy still feels angry and Sean doesn't feel angry.
B. Now Billy doesn't feel angry and Sean feels angry.

Why? _____

3. Christine is good at art and drawing. Betty is not good at art and drawing. Then Christine and Betty switched hands. Christine now has Betty's hands. Betty has Christine's hands. What are Christine and Betty like?

- A. Christine is still good at art and drawing and Betty is not good at art and drawing.
B. Now Christine is not good at art and drawing and Betty is good at art and drawing.

Why? _____

4. Jill's hair grows fast. Lori's hair does not grow fast. Then Jill and Lori switched hair. Jill now has Lori's hair. Lori has Jill's hair. What are Jill and Lori like?

- A. Jill's hair still grows fast and Lori's hair does not grow fast.
B. Now Jill's hair does not grow fast and Lori's hair grows fast.

5. Jeremy easily falls in love with other people. Joe does not easily fall in love with other people. Then Jeremy and Joe switched hearts. Jeremy now has Joe's heart. Joe has Jeremy's heart. What are Jeremy and Joe like?

- A. Jeremy still falls in love with other people easily and Joe does not fall in love with other people easily.
B. Now Jeremy does not fall in love with other people easily and Joe falls in love with other people easily.

Why? _____

6. Ben is happy and smiling. Chris is not happy and smiling. Then Ben and Chris switched faces. Ben now has Chris' face. Chris has Ben's face. What are Ben and Chris like?
- A. Ben is still happy and smiling and Chris is not happy and smiling.
 - B. Now Ben is not happy and smiling and Chris is happy and smiling.
7. Alice is able to stick to a project without having to be told to finish it. Amy is not able to stick to a project without having to be told to finish it. Then Alice and Amy switched hearts. Alice now has Amy's heart. Amy has Alice's heart. What are Alice and Amy like?
- A. Alice is still able to stick to a project without having to be told to finish it and Amy is not able to stick to a project without having to be told to finish it.
 - B. Now Alice is not able to stick to a project without having to be told to finish it and Amy is able to stick to a project without having to be told to finish it.
8. Kim's paper cuts on her fingers heal fast. Mary's paper cuts on her fingers don't heal fast. Then Kim and Mary switched fingers. Kim now has Mary's fingers. Mary has Kim's fingers. What are Kim and Mary like?
- A. Kim's paper cuts on her fingers still heal fast and Mary's paper cuts on her fingers don't heal fast.
 - B. Now Kim's paper cuts on her fingers don't heal fast and Mary's paper cuts on her fingers heal fast.

Why? _____

9. Trent is mean and wants to fight. Bob is not mean and doesn't want to fight. Then Trent and Bob switched hands. Trent now has Bob's hands. Bob has Trent's hands. What are Trent and Bob like?
- A. Trent is still mean and wants to fight and Bob is not mean and doesn't want to fight.
 - B. Now Trent is not mean and doesn't want to fight and Bob is mean and wants to fight.
10. Lynn remembers how to play the piano. Helen does not remember how to play the piano. Then Lynn and Helen switched fingers. Lynn now has Helen's fingers. Helen has Lynn's fingers. What are Lynn and Helen like?
- A. Lynn still remembers how to play the piano and Helen does not remember how to play the piano.
 - B. Now Lynn does not remember how to play the piano and Helen remembers how to play the piano.

11. Tom's skin rashes go away quickly. Ronny's skin rashes do not go away quickly. Then Tom and Ronny switched skin. Tom now has Ronny's skin. Ronny has Tom's skin. What are Tom and Ronny like?
- A. Tom's skin rashes still go away quickly and Ronny's skin rashes do not go away quickly.
- B. Now Tom's skin rashes do not go away quickly and Ronny's skin rashes go away quickly.

Why? _____

12. Melissa wants to meet new people and talk all the time. Julie does not want to meet new people and talk all the time. Then Melissa and Julie switched mouths. Melissa now has Julie's mouth. Julie has Melissa's mouth. What are Melissa and Julie like?
- A. Melissa still wants to meet new people and talk all the time and Julie does not want to meet new people and talk all the time.
- B. Now Melissa doesn't want to meet new people and talk all the time and Julie wants to meet new people and talk all the time.

Why? _____

13. Stephanie has strong teeth. Judy does not have strong teeth. Then Stephanie and Judy switched teeth. Stephanie now has Judy's teeth. Judy has Stephanie's teeth. What are Stephanie and Judy like?
- A. Stephanie still has strong teeth and Judy does not have strong teeth.
- B. Now Stephanie does not have strong teeth and Judy has strong teeth.
14. Jack feels worried. Mike does not feel worried. Then Jack and Mike switched eyes. Jack now has Mike's eyes. Mike has Jack's eyes. What are Jack and Mike like?
- A. Jack still feels worried and Mike does not feel worried.
- B. Now Jack does not feel worried and Mike feels worried.

16. Alex is nervous and upset. Travis is not nervous and upset. Then Alex and Travis switched stomachs. Alex now has Travis' stomach. Travis has Alex's stomach. What are Alex and Travis like?
- A. Alex is still nervous and upset and Travis is not nervous and upset.
- B. Now Alex is not nervous and upset and Travis is nervous and upset.

Why? _____

APPENDIX C

SUMMARY OF INDIANOLA MIDDLE SCHOOL'S AND COLUMBUS CITY SCHOOL DISTRICT'S PERFORMANCE ON THE OHIO SIXTH GRADE PROFICIENCY TEST

Summary of Indianola Middle School's Performance on the
Ohio Sixth Grade Proficiency Test

	WRITING			READING			MATH		
	Total Tested	# Above Passing	%	Total Tested	# Above Passing	%	Total Tested	# Above Passing	%
Total Group	134	52	39	132	17	13	142	16	11
Male	49	20	41	54	7	13	57	7	12
Female	81	31	38	75	10	13	80	9	11
Other	4	1	25	3	0	0	5	0	0

	CITIZENSHIP			SCIENCE		
	Total Tested	# Above Passing	%	Total Tested	# Above Passing	%
Total Group	141	29	21	136	12	9
Male	56	9	16	51	6	12
Female	80	20	25	81	6	7
Other	5	0	0	4	0	0

Summary of Columbus City School District's Performance on the
Ohio Sixth Grade Proficiency Test

	WRITING			READING			MATH		
	Total Tested	# Above Passing	%	Total Tested	# Above Passing	%	Total Tested	# Above Passing	%
Total Group	4274	2714	64	4289	1117	26	4282	1162	27
Male	2132	1214	57	2158	507	23	2148	574	27
Female	2117	1489	70	2105	607	29	2107	586	28
Other	25	11	44	26	3	12	27	2	7

	CITIZENSHIP			SCIENCE		
	Total Tested	# Above Passing	%	Total Tested	# Above Passing	%
Total Group	4272	1826	43	4232	1091	26
Male	2140	849	40	2119	579	27
Female	2108	973	46	2092	511	24
Other	24	4	17	21	1	5

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