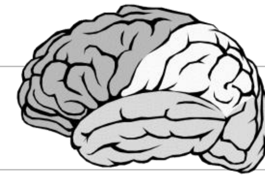
CDN Lab Newsletter

Fall 2008 - Cognitive Developmental Neuroimaging Lab

Research Projects



General Information

Fall has arrived, which means it is time for a CDN Lab Newsletter update! We want to thank all the children, adults, and families who participated in our research studies during the past three years.

Inside this newsletter you will find summaries and updates about the projects we have conducted from 2005-2008.

We suggest you first read the "types of studies" section below to learn the basics about the research studies we conduct in our lab. Thank you again for all of your help, and happy reading!

Types of Studies

Learn about the different types of studies conducted in our lab:

Behavioral

In behavioral studies we ask participants to do tasks such as play computer games, play card sorting games, and fill out paper and pencil questionnaires.

We are interested in things like how quickly participants respond during parts of the computer games, if participants get better after practicing our games, and if adults and children play these types of games differently.

EEG

For EEG studies we ask participants to wear a special net that looks like a swim cap while playing computer games or looking at pictures. The net is made out of elastic and has sponge-tipped electrodes. These electrodes allow us to record the signals made by the brain when participants are wearing the net.

ERPs (Event Related Potentials) are part of the EEG signal that we are interested in because they can measure the SIZE and TIMING of the electrical signals your brain makes when it is working hard.

MRI

Functional MRI (Magnetic Resonance Imaging) scans measure the changes in blood flow within your brain that tell scientists WHERE in your brain it's working hard.

During an fMRI scan we ask participants to lie very still in a long tunnel that is part of a machine that takes hundreds of pictures of the brain.

While holding still we ask participants to play simple computer games or look at pictures so that we can figure out what parts of the brain participants are using to do these tasks.

Learning About Hidden Patterns Studies

A. Introduction to Spatial and Object Pattern Learning

In a large project with three separate studies, we have been examining how learning changes with practice. We ask adults and children to tag cartoon characters that appear on the computer screen. The pictures sometimes follow a hidden pattern but other times their movements are random. We look at how quickly people can tag the characters to determine whether they learned the hidden pattern or not. We measure learning by seeing whether people are faster at tagging the characters during the patterned parts of the game than when there are no patterns.

In a study we conducted several years ago, we explored whether these changes in learning differ depending on whether the hidden pattern is based on spatial information (e.g. *where* the cartoons appear) versus identity information (e.g. *who* are the target cartoon characters). The results of this first study revealed an intriguing developmental difference. We found that while adults learn spatial and identity patterns equally well, 8 year-old children are much more successful when learning the spatial patterns compared to the identity patterns. Why might this be the case? We have since conducted several follow-up studies in order to understand the factors that may contribute to this developmental change in pattern learning.

1. Effect of Attention – Scooby Doo and Looney Tunes Games

In the first of these follow-up studies, we examined whether different attention requirements influenced the discrepancy in children's ability to learn the spatial vs. identity patterns. To explore this possibility, we designed two new tasks that equated attention demands, regardless of whether participants saw the spatial or the identity patterns.

In the Scooby Doo game, participants saw multiple cartoon characters and were asked to respond when the cartoons appeared in a specific location. In the second task, known as the Looney Tunes game, participants again saw multiple cartoon characters that appeared in multiple locations on the screen. This time participants were asked to respond when they saw a specific character, regardless of where they appeared on the screen.

Thus, the two tasks looked identical on the surface and required equal shifts of attention, despite the fact that participants were exposed to a spatial pattern during the first task and an identity pattern during the second task. The results of this study revealed that once again, adults demonstrated equivalent learning of the spatial and identity patterns, while 8 year-olds showed successful learning of the spatial pattern, but not the identity pattern. These results suggested that something beyond the degree of attention demands contributes to this difference in pattern learning among 8 year-olds.

2. Effect of Task Complexity – Colors Game

In the second follow-up study, we explored whether the complexity of the cartoon characters made the identity pattern harder to learn. Usually when we conduct our pattern learning studies we try to make the games more engaging by including popular cartoon characters and colorful backgrounds. However, we were concerned that by making the game more interesting we might also be making it more complex for participants and possibly affecting how much information can be learned about the hidden patterns.

In the colors game, adult participants watched multiple colors appear in a single location on the screen and were asked to respond when specific colors appeared. Thus, this task is identical to the original identity task, except that the identity information (e.g. color identity) was much less complex than the original cartoon characters. Results from this study indicated that adults learn an equal amount about the identity patterns in all of our games, regardless of how simple or complex we make them.

Because there was no difference in learning based on complexity among adults, we decided not to pursue this task with child participants.

3. Effect of Eye Movements – Eyes Game

More recently we have been exploring whether children's greater success at learning the spatial patterns might be related to the extent to which they move their eyes during the task. Though we don't often think of an eye movement as a major motor behavior in everyday life, previous research has shown that eye movements can provide substantial information when we learn about patterns around us.

In our final follow-up study, we are looking at whether participants continue to learn the spatial pattern even if they refrain from making eye movements during the task. So far, we have found that adults can still learn about the pattern, even if they are not moving their eyes. We are still actively recruiting 8-year-olds to participate in this study. At this point in time, we are not sure if 8-year-olds are learning the hidden pattern but we have noticed that they do have more trouble keeping their eyes still than adults!

We are continuing to explore these intriguing differences in children's ability to learn spatial and identity patterns, in an effort to understand the factors that contribute to these differences during childhood, as well as the developmental factors that allow us to successfully learn about both types of patterns as adults.

As part of this overall project, we eventually plan to use functional MRI measures to see whether different brain systems support learning of spatial vs. identity patterns.

B. Effect of Task Design on Pattern Learning

In a separate series of studies, we have been identifying different methodological factors that influence how well the hidden patterns can be learned. A number of years ago, our lab conducted a large study that examined how different responses affect learning. Prior to this study, nearly all pattern learning studies asked participants to respond by pressing multiple buttons that corresponded to all of the different pictures on the computer screen. In our lab's study, we compared this traditional design with two new tasks. One of these new tasks, known as the 4-Target task, asked participants to continue to press multiple buttons, but only when they saw specific cartoon characters appear on the screen. In the second new task, known as the 1-Target task, participants pressed a single button only when they saw the specific characters appear. The results of this study showed that both adults and 8 year-old children learned the hidden pattern regardless of how they responded.

One possibility however, is that participants appear to learn the pattern in these modified tasks because they are sensitive to the timing of *when* the target characters were presented. If this were the case, it would cast doubt on whether participants learned the true hidden pattern. To test this possibility, we repeated the previous task, but staggered the timing between when the cartoon characters appeared. The results of this study again showed that both adults and children learn the pattern, even when the timing information is not reliable. This suggests that participants show equivalent learning across these different response parameters.

C. Effect of Task Pace on Pattern Learning

In our last set of pattern learning tasks, we explored how the pace of information presented affects the learning of hidden patterns. In this study, 4 year-old children and adults played tag with Elmo and his friends by pressing buttons on a button pad in response to seeing different Sesame Street characters appear on the computer screen. During the study, preschoolers and adults play 1 of 2 versions of the Elmo game: a version in which the characters appear at a predetermined speed (the fixed-pace version), or a version in which a new character does not appear until the child has tagged the previous character (the self-paced version).

We are almost finished with this study (over 60 children have participated), but have already found that like older children and adults, preschoolers are faster at "tagging" the characters during the patterned sequences, which suggests that they are able to learn the hidden pattern. Our preliminary results with the 4 year-olds also suggest that the preschoolers are more accurate and show somewhat greater learning when they can play the game at their own pace. For adults the pace of the game does not appear to matter, as adults seem to learn the same amount of information about the hidden pattern in both of the games.

Understanding Faces Study

Can you tell how this person is feeling by just looking at her eyes or her mouth?

In the Understanding Faces study we are interested in how children respond to people's faces.

We asked 8-year-old children to play face card-sorting games that involved looking at pictures of people who felt either happy, mad, sad, or scared. Sometimes these were whole faces with a gray stripe that covered the nose area and sometimes the pictures just showed the eye or mouth region of the face. We asked kids to decide how the people in these pictures felt and sort them into labeled bins. We included this game because we wanted to know if children and adults understand faces in the same way or in different ways. Prior to recruiting kids for this study, we had already tried these games with a number of adults.

We also played a face matching game where we asked children to put together pictures of eyes and mouths that felt the same way. The reason we did this is because we wanted to know what part of the face is more important when kids are deciding how someone feels. We also wanted to know if it was easier or harder to tell how someone feels from just the eyes or just the mouth.

We are still testing 8-year-olds in this study but preliminary results do indicate that children and adults perform differently on these tasks. For example, sometimes and kids and adults pay attention to different parts of the face depending on emotion.

For this study we also collected a sample of DNA from the children who participated. Since certain genes are important during children’s brain development, we were interested in how normal differences in one specific gene might be related to how children understand faces.

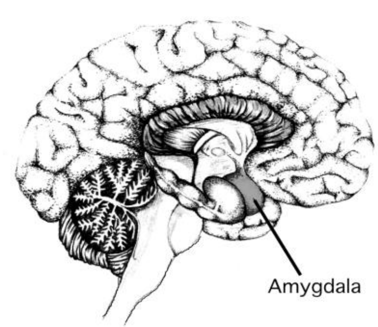
Understanding Faces MRI Study

Some of the children who participated in the Understanding Faces study were also asked to come back to participate in another study about how children understand faces that used functional magnetic resonance imaging (fMRI).

For part of this study we were interested in how the brain can recognize different emotions- for example, can the brain recognize an emotion just by seeing parts of they eyes? Previous studies have suggested that a certain area of the brain called the amygdala may be so sensitive to potential threats in our environment that it might be activated even before we are consciously aware of the danger. To examine this we had 8-year-old children play a computer task while they were in the MRI scanner. In our computer task, we actually showed two different stimuli at almost the same time. The first picture was just of the whites of eyes from different emotional faces and this image appeared for just 26 milliseconds - too fast for most people to know what they are seeing. The second picture was a whole face presented immediately after for a longer period of time, so that most participants were not aware that there had been a first face. We wanted to find out whether the amygdala was able to see the first picture of the eye whites even though the participant was not conscious of having seen it.

Additionally, children who participated in this study were asked to play a face emotion matching game while they were in the MRI scanner. In this task, children were shown pictures of angry and fearful faces and asked to match the faces that felt the same way. This is a game that has been to shown to activate the amygdala in previous adult studies and we wanted to see if kids responded in the same way or differently. We are particularly interested in how children learn to recognize different facial expressions, and how the brain develops its response to facial emotions.

We are still looking for 8-year-old children to participate in this project and hope to finish by the end of November.



Faces and the Brain – EEG Study

In the Faces and the Brain study, we showed participants pictures of human faces showing different emotions and we measured brain activity by using the Event-Related-Potentials (ERPs) technique. ERPs measure the electrical activity of the brain by using a damp, elastic net with sponge-tipped electrodes that is worn like a swim cap. We were interested in finding whether there is a different pattern of brain response depending on the emotion shown in the face photos. If there are different responses to different emotions then that could mean that that we, for example, recognize and process negative emotions faster than positive emotions.

We are also interested in finding out whether the brain can recognize facial expressions of emotion even when we can't explicitly see them. Previous research has shown that a certain area of the brain called the amygdala is very sensitive to potential threats in our surroundings. In fact, the amygdala might be activated even before we are consciously aware of danger in our environment. To study this in our computer task, we showed participants two different emotional faces at almost the same time. One face appeared for just 26 milliseconds - too fast for most people to know what they are seeing - and a second face was presented immediately after for a longer period of time, so that most participants only reported seeing the second face. We wanted to find out whether brain responses indicated that the first face was seen even though it was presented too quickly for awareness.

We've tested adults and children (4 and 9 year olds) in this study and we are in the process of analyzing these data. You can see an example of what our EEG net looks like in the picture above.

Attention and Emotions in Teenagers Study

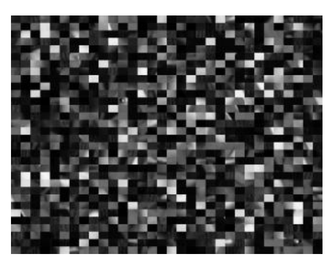
In this study we are looking at how well teenagers and adults can pay attention while there is distracting emotional information in the background. To test this, we are using a go-nogo task. In this task, participants are asked to push a button every time they see a letter appear on the screen, unless the letter is an X. If an X appears, they need to hold back their response and not push the button. This is hard to do because, as people push the button for each letter that appears, they build up a tendency to respond, so they have to keep paying close attention to the task in order to not push the button when an X appears.

In some parts of this task, there are scrambled pictures in the background so we can look at how well people pay attention without distracting emotional information. In other parts of the task, the pictures are not scrambled and instead show things that are positive (like ice-cream and kittens), negative (like spiders and people crying) or neutral (like a cup or a building.).

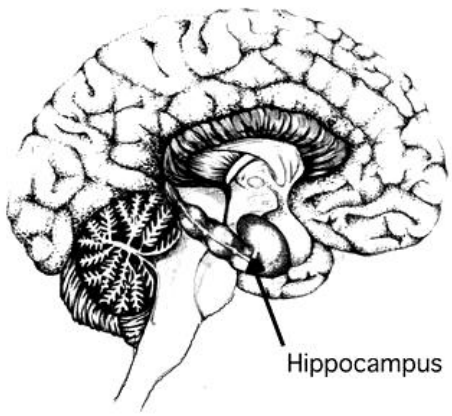
So far in this study, we have tested several groups of participants between the ages of 11 and 25 years. We have found that people generally take longer to hit the button when there is a negative picture in the background. The study also shows that people get better at not hitting the X as they get older. However, for 13-14 year-olds, compared to older and younger participants, there is a bigger difference between how well they do when there is a negative picture in the background versus when there is a positive, neutral or scrambled picture. In other words, young adolescents seem to be more easily distracted by emotionally negative information. We think that the emotional pictures are more distracting for these teenagers because parts of their brains that control attention and help regulate emotions are still developing.

To follow up these results, we are about to begin a functional MRI study, using the same task, so that we can look at whether teenager's brains activate differently from adults when they are trying hard to pay attention under emotionally distracting conditions.

Parallel experiments are looking at the influence of a minor social rejection on the ability to do a go-nogo at different ages and stages of puberty.



Attention and Learning in Children

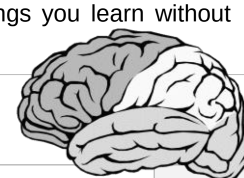


Finding Nemo Game

In the Finding Nemo experiment, players saw screens filled with orange and white clown fish and had to find Nemo, the one fish with three up-and-down stripes. When the players found Nemo, they pressed a button to tell us if he was swimming to the right or to the left. We didn't tell people, but some of the screens repeated throughout the experiment and others never repeated. Amazingly, no one ever noticed that some of the screens repeated!

We wanted to figure out if people learn from the repeating screens, even though they don't know about them. We did this by looking at how fast people could find Nemo in screens that repeated and in screens that didn't repeat. It turns out that with practice, people find Nemo faster in screens that repeat than in screens that don't repeat, but without ever knowing it! This is true for both adults and 9-year-old kids.

In our most recent experiments, we asked some adults to play the Nemo game while we measured their brain activity using functional MRI. We found that one part of the brain, called the hippocampus, seems to be working harder in people who learn a lot from the repeating screens. This is interesting because this part of the brain is usually important for remembering things that you want to remember, rather than for things you learn without noticing.



Selective Attention Study

Selective attention is composed of both selecting out relevant information and ignoring (or filtering out) unwanted information. However, while we know that selective attention develops across childhood these two aspects of selective attention had not been studied in relation to each other in childhood. Thus, this study looked at selective attention in 10-year-olds using a task that allowed us to measure both the selective and the filtering aspects of attention.

In this study children were asked to search through pictures to find a letter T among both green and red L's. We were able to measure children's ability to select out the relevant information by asking children to look through the L's of one color to find the T (which was also in that color). Just as with adults, 10-year-olds showed faster times when there were fewer L's in the color they were searching through. In other words, if looking for a red T among red L's, if there were 4 red L's and 12 green L's they were faster at finding the T than if there were 12 red L's and 4 green L's. Thus 10-year-olds showed adult-like selection in this task.

However, we were also able to look at children's ability to filter by measuring how much they learned about the pattern of L's that appeared in the pictures. In adults, if the same pattern of L's appears repeatedly, they get faster at finding the T, but only if the repeating pattern of L's is in the color they are searching through. However, children did not show this learning in most cases. Children only showed learning when the pattern of L's repeated when either all of the L's (both green and red) were in a repeating pattern or if there were many more L's in the color they were searching through as compared to those they were supposed to ignore (ie searching through 12 red L's and 4 green L's for a red T). Thus, the L's in the color they were not searching through were more distracting for children than adults demonstrating that children's filtering is not as developed as adults at the age of 10.

This suggests that these two aspects of selective attention develop at different rates and it is children's inability to ignore irrelevant information rather than their ability to select out the appropriate information that contributes to their immature selective attention as compared to adults.

Attention and Learning in Infancy

In our series of infant experiments we are exploring how infants learn about the world during the first year of life. Given that infants are faced with a massive amount of information in their surroundings, we are especially interested in how infants identify what information is most interesting or important to learn about. This is especially intriguing since young infants cannot simply be told to pay attention to specific items. With our infant studies, we are trying to understand how the development of attention might contribute to infants' ability to learn about their world. So far this series of studies has involved three phases, a first phase involving a basic attention task, a second phase involving a learning task, and a third phase that involves both attention and learning.

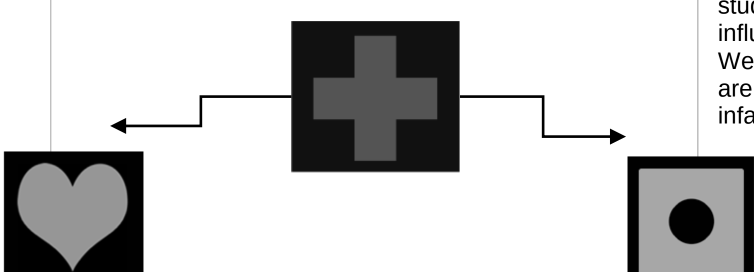
1. Attention Study

In the first phase, we invited 7 month-old infants and their parents to watch a short movie in which brightly colored shapes appeared in different locations on the screen. In addition to these shapes, there was a bright yellow circle, known as the cue, that very briefly appeared in one of the locations in which another shape later appeared. Because we can't ask infants what they find most interesting, we assess their attention by watching their eye movements as the look at the various shapes. We ultimately gather information about where the infants look and how quickly they look at the shapes when they appear.

From this first phase we have found that the brief yellow cue has substantial influence on both where and how quickly infants look towards the shapes.

These results provide important information showing that infants' attention is sensitive to perceptual cues, which means that information in the environment can guide infants' attention before they can understand verbal information about where to look.

In our Infant Learning Study, we showed 7-month-olds colorful shapes that always appeared in the same pairs. In the example below the cross would always be followed by the heart or the square. We wanted to know if infants could learn these predictable relationships.



2. Learning Study

In the second phase, we explored whether infants of the same age can learn about predictable relationships among these shapes. As in the previous phase, infants watch a short movie with brightly colored shapes appearing in multiple locations. In this phase, however, specific shapes were always followed by the same shape. For example, when babies saw a blue cross appear, it was always immediately followed by a green heart. Infants watched these same sets of shapes appear in the movie for about 5-10 minutes. During the last minutes of the movie we showed the infants some pairs of shapes that they had already seen and some pairs of shapes that were brand new combinations. Again we gathered information about where the infants looked and how long they looked at the different pairs of shapes to determine if they had learned about the predictable relationships.

We found that some infants spent much more time looking at shape pairs that were old/familiar to them, while other infants showed a preference for the new shape pairs.

These results suggest that infants were noticing the predictive information in the movie and are sensitive to regularities in their environment.

3. Attention and Learning Study

Our third phase of the study will combine the attention and learning components of the previous studies to examine how the development of attention influences what infants learn from their environment. We are just beginning this phase of the project and are currently looking for families with 7-month-old infants who are interested in participating.

We are also interested in studying the relationship between attention and learning across development so we are conducting a set of similar studies with adult participants.

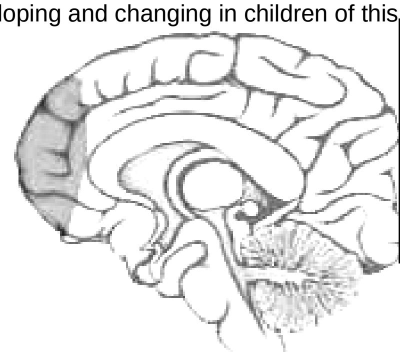
Learning and Memory Study

How do kids and adults pay attention and learn new things? Do their brains work in the same ways or in different ways than an adult brain? That is what we are interested in finding out in this study. As part of a longitudinal study we have studied forty kids (8-10 years old) and sixty-two adults while we recorded EEG and functional MRI signals during learning, memory, and attention tasks. While we measured when and where the brain was working, both adults and kids played two special games that are designed to use different structures within the brain. Kids also did a special interview about memories from their lives.

Pokémon Game

One of the games was called "The Pokemon Game". Like the Attention and Emotion Study in Teenagers study from page 5, this game was also a go-nogo. For this game, people were told to press a button for Pikachu but not for the snake, Arbok. Most of the pictures were Pikachu (75%), so it was especially hard to not press the button for Arbok.

This game helps us learn about how you pay attention and how your brain inhibits your responses, relying on very front part of your brain called the prefrontal cortex. So far, our study shows that this it is much harder for kids to not press for Arbok then it is for adults. This is because the prefrontal cortex is still developing and changing in children of this age.

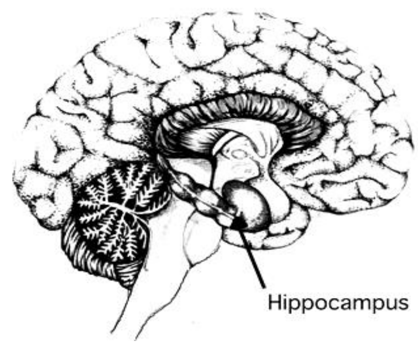


The prefrontal cortex includes all of the area highlighted in dark grey in the frontal lobe of the brain.

Memory Game

The other game was a memory game where people saw many different pictures and pressed different buttons for new pictures and pictures that had already been seen. Additionally, the pictures were different types, some objects you see everyday and others that were really strange that you couldn't name.

This game helps us understand how we learn and remember new things and if recognizing an object helps you remember it better. We are most interested in a part of your brain called the hippocampus, which is found in your temporal lobe. We think that the hippocampus is also still developing and changing in children of this age.



Autobiographical Memory Interview

In this part of the study, we were interested in what children can remember about things that happen to them in their lives. We asked children to come up with memories of specific events that they experienced at a particular time and place, in response to eight different words (such as dog, pond and money).

We are just starting to look at this task, and want to find out more about what children can remember from different times of their lives. For example, do they come up with more memories from preschool years or ones that happened more recently? As adults, it is difficult for us to remember from before age 3, but is this also the case for children? We also would like to look at how children talk about those memories. For example, do they provide a lot of details and background, do they mention things like who was present, when and where the event happened, and how they were feeling at the time?

In addition to this task, we also asked parents to talk with their children about life events in an effort to learn about how parents and children interact as they reminisce about the past, and what aspects of the event they focus on together.

Participating in Future Research

As of Fall 2008, our lab is currently recruiting children of various ages for the following research projects:

1. 7-month-olds infants (Attention and Learning During Infancy)
2. 4-year-old children (Effect of Task Pace on Pattern Learning)
3. 8-year-old children (Effect of Eye Movements on Pattern Learning)
4. 13-year-old children (Attention and Emotion in Teenagers – fMRI Study)

We are also recruiting healthy adults between the ages of 18 and 35.

For continued updates or information on how to participate in our current studies, please visit our lab on the web at http://cehd.umn.edu/icd/CDNLab or call the CDN Lab at 612-624-0075.

To add or remove a child from the Institute of Child Development's list of potential participants, please contact the Infant Participant Pool at 612-624-7009 or by email at IPP@umn.edu.

Neuroscience Websites for Kids

Brainy Kids (DANA) : http://dana.org/resources/brainykids/default.aspx
Neuroscience for Kids (University of Washington) : http://faculty.washington.edu/chudler/neurok.html
Your Brain and Nervous System (Kids Health) : http://kidshealth.org/kid/htbw/brain.html

Thanks for all of your help!

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