

# BRAIN CHANGES AND THE EFFECTS ON COGNITION

## Information About Parts of the Brain, Cognitive Abilities, and Dementia Shelly Weaverdyck

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This is an adaptation of the handout Caring Sheet #2 from the Michigan Dementia Care Series. More information is at the end of this Handout.

The Michigan Dementia Care Series can be found on the Michigan website called Improving MI Practices at <https://www.improvingmipractices.org>

This handout describes the **effects** on **cognitive abilities** of **changes** in specific parts of the **brain**. It also describes changes in the brain that occur with dementia.

### FOR MORE DETAIL AND INTERVENTION STRATEGIES

Various parts of the brain, brain changes, and cognitive abilities are discussed in more detail in other **CAIS Handouts** (such as **Handout #8**), the **CAIS Educational Series** and the **background resources**.

More specifics and suggestions of intervention and support strategies to address cognitive changes are in **other CAIS Handouts** and in the *Cognitive Abilities and Intervention Strategies (CAIS): Cognitive Abilities Questions to Ask* and the *CAIS Cognitive Intervention Strategies* by S Weaverdyck. These provide **detailed intervention** strategies that address specific cognitive abilities, the environment, tasks and daily routines, and your communication with this person. These interventions can be **individualized** to a particular person and situation.

For a summary of information and possible intervention strategies for specific disorders, see **CAIS Handout #35** about the **frontal lobe**, **#36** about the **right hemisphere**, **#19** about **Alzheimer's Disease**, **#20** and **#37** about **Dementia with Lewy Bodies**, and **#21** and **#38** about **Frontotemporal Dementia**.

All of these above are available on the website at <https://www.improvingmipractices.org>

### INTRODUCTION

This handout describes the impact changes in the brain can have on a person's cognitive abilities. Cognitive abilities include a person's ability to think, to imagine, and to process information so this person can understand and respond to their surroundings and other people.

**Each part** of the brain is associated with **specific cognitive abilities**. Another CAIS Handout (#6) lists some of the cognitive abilities associated with each of three parts of the brain, including the frontal lobe, the temporal lobe, and the parietal lobe.

When changes occur in a part of the brain, regardless of the reasons or causes of those changes, the specific cognitive abilities associated with that part are affected. That is, the effects on cognitive abilities apply to any changes in specific parts of any person's brain, regardless of the disorder or causes of the changes.

The resulting changes in cognitive abilities can then lead to changes in **behavior** and a person's **ability to perform tasks**.

These two **CAIS Handouts (#6 and #7)** are written as **companion pieces** with corresponding lists of cognitive abilities that can be affected by brain changes in the frontal, temporal, and parietal lobes.

This handout also describes changes that occur in the brain of a person living with dementia.

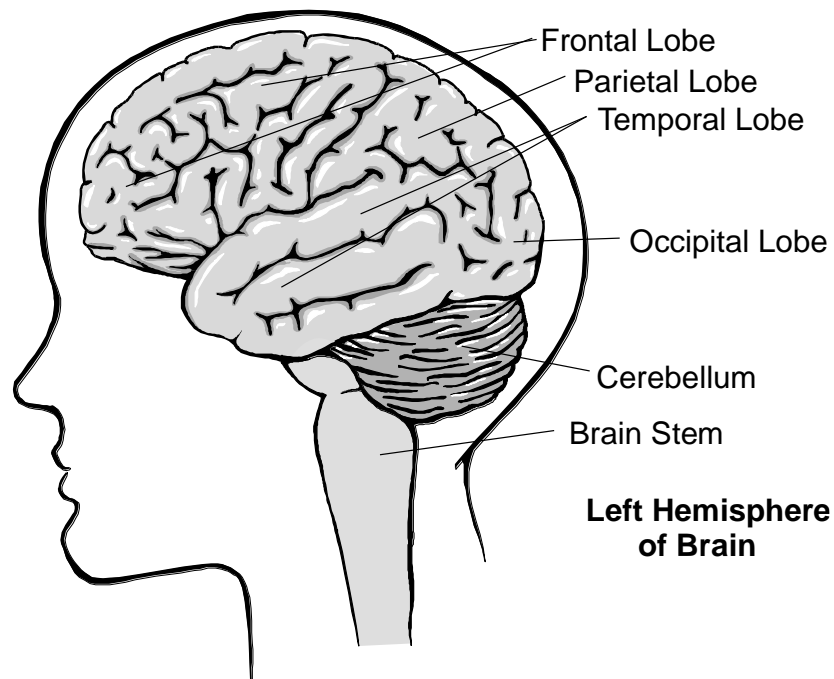
## **THE BRAIN**

Changes in specific parts of the brain correlate with changes in specific cognitive abilities.

The structure of the brain and organization of its cognitive abilities was described in CAIS Handout #6. The focus of that handout (and of this handout) is the **cortex**, the noodle-like surface of the brain where the most sophisticated intellectual thought processes take place. In general, the amount of surface area of the cortex correlates with the individual's quality of intellectual functioning.

CAIS Handout #6 described the two halves of the brain (the **left and right hemispheres**) and three of the four lobes which compose each cerebral hemisphere (the **frontal, temporal and parietal lobes**). (See Figure 1.) It noted that each lobe and hemisphere has its own set of cognitive abilities in which it plays a major role. It listed some of those cognitive abilities.

Changes in the frontal, temporal, and parietal lobes in the cortex are related to the changes in the cognitive abilities listed in CAIS Handout #6. (Other important cognitive changes can result from changes in the fourth lobe, the occipital lobe, including changes in the ability to see.)



**Figure 1: Schematic drawing of the brain, including the left cerebral hemisphere, cerebellum and brain stem. *Size of the brain with respect to the outline of the head is not to scale. The right side of the brain is essentially a mirror image of the left. The right cerebral hemisphere has the same four lobes.***

## INDIVIDUALIZED BRAIN ORGANIZATION

The lobes of the brain actually overlap and interact in their roles regarding specific cognitive abilities. These lobes communicate with each other in ways that are **unique** to each **individual person**. The listing here of specific cognitive abilities as the province of each lobe, therefore, is an oversimplification and generalization, though there is a strong correlation between changes to specific lobes and corresponding changes in specific cognitive abilities.

Cognitive abilities are organized in the brain according to a person's structural dominance, as is usually evidenced by hand dominance. Here, we are assuming the cognitive abilities described are of a typical right handed person. (This would pertain to most, but not all left handed persons as well.)

## CHANGES IN COGNITIVE ABILITIES AND PARTS OF THE BRAIN

A person's **brain changes** over a **lifetime** due to, for example, growth, maturation, experiences, their environment, and various illnesses and disorders.

The changes in cognitive abilities listed here reflect brain changes that make the cognitive ability **more difficult** for this person, for example, changes from an injury or a disorder.

These are a few examples of the **many** changes in cognitive abilities that occur as the brain changes.

For each of these examples below that illustrate a change in cognitive ability, there may be a **variety** of reasons or explanations for the behavior cited. Changes in the particular lobe identified might be one possible cause, reason, or explanation.

The changes are listed in an **order** that **corresponds** to the list of cognitive abilities in **CAIS Handout #6**.

### LEFT HEMISPHERE

When part of a person's left hemisphere changes:

1. The right side of their body may be weaker or less able to move.
2. The right side of their body may be altered in its ability to feel, notice, recognize, or respond to stimuli (visual, auditory, or tactile).
3. This person may have more difficulty following the logic of an explanation or order of task steps.
4. This person may have slurred speech or difficulty finding words they want to use.

### RIGHT HEMISPHERE

When part of a person's right hemisphere changes:

1. The left side of their body may be weaker or less able to move.
2. The left side of their body may be altered in its ability to feel, notice, recognize or respond to stimuli (visual, auditory, or tactile).
3. This person may have difficulty judging distances or locating objects in space relative to other objects and to this person.
4. An environment with many objects or much movement might be upsetting or fatiguing for this person.

### FRONTAL LOBE

When the frontal lobe changes, **many** cognitive challenges occur. For example, a person may have difficulty:

1. Recognizing which stimulus or piece of information is most important to pay **attention** to, that is, how to **prioritize among** all the **stimuli** they receive from other people and their surroundings. They may simply respond to the most powerful stimulus at the moment.
2. **Organizing** objects or to do lists, **problem solving**, or **planning** a task. For example, they may not know how to prepare a meal, or to organize and sort through many objects they have collected.
3. **Making decisions** large and small, for example, what to have for breakfast or which objects to keep and which to throw away.
4. Creating and holding a **variety of options** in mind and then choosing from among them, for example, thinking of ideas for conversation, of activities to relieve boredom, or of possible explanations for an event. (For example, they may think the only explanation for odd tasting water is that you are poisoning them.)
5. Knowing when a task is done and then **stopping** the task. They may not be able to keep in mind the goal or outcome of a task or may not recognize when they have achieved the task goal. Or they may not be able to stop themselves from continuing a task step even after the task is done. (For example, they may continue to dip the spoon into a bowl and bring it to their lips long after the bowl is empty.)
6. **Initiating** a task. For example, this person may sit in front of a lunch plate and start eating only when someone initiates the process for them. Or they may seem to be unable to stop lying on the couch and go do something they say they want to do. They may appear to be lethargic or uninterested.
7. Conceptualizing or recognizing the **order of task steps** or **items**, for example, the order of clothes to put on, or the steps to preparing a meal.
8. **Staying focused** on a task or thought until it is complete. They may appear to simply stop doing a task before it is done, or stop focusing regardless of where they are in a task or a conversation. They may seem to become more **easily distracted**, fatigued, or irritable after a short time of focused attention. When someone brings their attention back to the task or thought, they may continue on with the task or thought. On the occasions when this person does something or makes comments that are distressing, ignoring the behavior or comments might sometimes help stop the action or comments as this person focus on the action or thought dissipates.
9. **Recognizing** their own **mistakes** and **correcting** them in social interactions and in other contexts. For example, they might pinch someone's breast and laugh about it, and not recognize the extent to which the action was inappropriate. Or they might take their clothes off because they are hot even though they are outside and visible to others.
10. **Knowing how much time has passed**. For example, they may sit down at the table to eat and then get up and walk away after a few bites. Or they may ask when dinner is twenty times in three minutes, because they thought perhaps a half hour had passed since they had last asked.
11. Understanding the **sequence** of events in the past versus present time, for example, recognizing the fact that since they are 90 years old and their children are in their 50s and 60s, they do not need to go home to feed their children.
12. Recognizing and **monitoring** their own thoughts, feelings, and behavior, including the depth of their own emotion or even that they feel angry, sad, or upset. They may have difficulty recognizing what they know, for example, they may know which chair they always sit in for lunch, but may say they don't know, even as they walk to the chair on their own and sit down. They may have difficulty consciously monitoring and "watching" themselves, and difficulty noting and changing their behavior. The intensity with which they express an **emotion** may not always match the intensity with which they feel the emotion. For example, they may cry many tears but feel only slightly sad, or swear profusely when they feel only slightly irritated.
13. **Discerning** triggers or **causes** of thoughts, feelings, and behavior, such as **analyzing why** they are feeling an emotion. For example, they may feel a desire to go home, but in fact they are anxious or need to use the restroom. They may not know they need to use the restroom or cannot think of any other reason for their anxiety or discomfort.

14. Controlling **impulsive** responses to thoughts and feelings, by censoring, delaying, or pacing their responses. They may have difficulty thinking twice before acting on or saying what comes to their mind. For example, they may impulsively swear or say “You’re ugly” to someone.
15. **Adapting** to new conditions or situations, or to a change in plans. They may feel anxious or be less able to do a task in unfamiliar surroundings or with unfamiliar task objects. For example, they may have difficulty brushing their teeth with pump toothpaste instead of tube toothpaste, or changing morning routines and bath times from past habits. They may be most relaxed and able to perform tasks most successfully when the timing and way of doing a task and the people with them are consistent and conditions are as they were throughout this person’s past. This person will likely become more dependent on consistency and predictability.
16. **Interpreting** or explaining events or a **situation** to themselves. When there is a surprise or change of plans, or something is new or unfamiliar, this person may have difficulty telling themselves messages that explain the situation. For example, they may have difficulty telling themselves there is no cream in the house, so they will need to use milk for their breakfast this morning; or that someone visiting them who looks like their deceased spouse is actually their offspring rather than their spouse.
17. Telling themselves messages to help them relax and feel comfortable. They may have difficulty reassuring and **soothing themselves**. For example, if this person’s favorite sweater is being washed and is therefore unavailable, this person may have difficulty telling themselves that the sweater will be available very soon, that it isn’t permanently unavailable.
18. **Switching** from one idea, thought, or **action to another**. For example, when this person is silently reminiscing about an event or someone from their remote past, it may be difficult for them to quickly “shift gears” and attend to or recognize someone who is walking by saying “hi” or who is asking them to take some medication. They may get confused when a topic shifts to another topic during a conversation. Or they may be focused on eating their applesauce during a meal, and appear to “stubbornly refuse” to stop when someone suggests they eat some bread instead.
19. **Imagining** something that is not visible or tangible (that is, it is **abstract**). They may have difficulty creating a picture in their mind of an object in order to understand or recall what someone is talking about. For example, choosing between two food options that are not in front of them, or understanding that a clear glass has water in it when the water seems invisible, or looking in a mirror and comparing what they see with an imaginary image (whether or not the image is conscious) of what they would prefer to see.
20. Thinking about or doing **more than one thing at a time**. For example, they may have difficulty thinking about the next task step when they are doing the current task step. Or they may get confused when someone enters their visual field and begins speaking at the same time. Or when someone asks them to stop spitting out their food because it looks disgusting, they may have difficulty changing their behavior and feeling embarrassed about their behavior at the same time.

## TEMPORAL LOBE

When the temporal lobe changes, **many** cognitive challenges occur. For example, a person may have difficulty:

1. **Understanding language** or the words another person is using. They may need more time to understand what someone is saying. (left temporal lobe)
2. **Producing the words** they want to use. They may need more time to express a thought in words. They may use fewer words or the wrong words or make nonsense sounds when they speak. They may substitute a word for a word with the same initial sound (for example, “pip” for “pen”) or describe the word (for example, “the thing you write with” for “pen”). They may say “Yes” when they mean “No”. (left temporal lobe and Broca’s area in the frontal lobe nearby)
3. **Remembering** very recent events or information, such as a visit from a friend who left just ten minutes ago. Or, for example, this person may forget what someone just said, or what they told someone two minutes ago and thus repeat the same story several times in a single conversation.

They may be surprised and angry when someone tries to take off their clothes because they forgot they had agreed to take a shower. They might have difficulty **knowing what to remember** and what to forget. They remember a dog barking rather than the information someone gave them while the dog was barking. (in cooperation with the **hippocampus**).

## PARIETAL LOBE

When the parietal lobe changes, **many** cognitive challenges occur. For example, a person may have difficulty (and therefore work hard):

1. **Noticing** people and objects in all parts of their **visual field** (that is, in the space in front of this person.) There may be a part of this person's visual field, where their eyes see all the objects and people, but their brain (that is, their parietal lobe) does not tell them to notice the objects and people, so it is as if this person doesn't see them. They may need someone to approach them from the front rather than from the side.
2. Recognizing information about the space around this person. For example, this person may have difficulty **recognizing where people or objects are** relative to each other and to this person's own body, especially when those people or objects are moving. This could include difficulty with following hand movements in gestures, putting their water glass down on the table beyond their dinner plate rather than on the edge of their plate, or reaching for an object when it is being handed to them. They may think your face is closer to their face than it is, or that your hand is moving to their face rather than their shoulder or is moving more quickly than it is (that is, that your hand is moving quickly to their face in an aggressive way). They may get frightened, **tired**, frustrated, **stressed**, or angry from working so hard to process confusing stimuli, too many objects, or movement in their environment. They are most likely **unaware** that they are working hard or why they feel distressed.
3. Performing tasks that require **manipulation of objects** or of their own body, especially in relation to other objects, such as dressing, aiming their hand and arm into the sleeve of their jacket, drawing a clock on a piece of paper, arranging dishes on the table for mealtime, or navigating large spaces (for example, from the living room to the bathroom). They may have difficulty descending stairs if they can't easily see how steep the stair steps are, how far away the bottom of the stairs is, where the edge of the stair step is, or where the railing is.
4. Performing simple arithmetic calculations or writing.
5. Responding to a request to walk, to do a simple task, or to move a part of their body.

## TO KEEP IN MIND

As was noted above, the changes in cognitive abilities listed in this handout reflect brain changes that make the cognitive ability **more difficult** for this person, for example, brain changes from an injury or a disorder. There are many changes in the brain that can make cognitive abilities easier.

When a person experiences an injury or brain disorder, the specific parts or lobes of the brain that are affected or change depend on the nature of this person's injury or disorder. Dementia is a useful illustration of the interaction between changes in specific parts of the brain and changes in their associated cognitive abilities.

## DEMENTIA

Dementia is a gradual decline in a person's cognitive abilities. This decline occurs because of changes in the brain.

Some changes in cognitive abilities in older adults can be **temporary** and **treatable** (for example, delirium) if they are caused by treatable disorders such as:

- Urinary tract infection and other infections
- Vitamin deficiency

- Diabetes and other metabolic disorders
- Reactions to medications
- Dehydration
- Pain
- Constipation
- Flu
- Depression

Other changes in cognitive abilities due to brain changes are **irreversible** and **progressive** (that is, increasingly severe) if they are caused by disorders such as:

- Alzheimer's Disease
- Dementia with Lewy Bodies (DLB)
- Frontotemporal Dementia (FTD)
- Vascular related dementia
- Others (such as Creutzfeldt-Jakob Disease)

This handout describes the irreversible, progressive brain changes and the resulting cognitive changes in dementia.

Sometimes both temporary and irreversible changes occur simultaneously. When the disorder causing the **temporary changes** is **treated immediately**, a person will more likely return to the level of cognitive functioning they had been experiencing with the irreversible brain changes.

**Alzheimer's Disease** is the most common cause of irreversible brain changes & dementia in persons over the age of 65 years. It affects a person's:

- Behavior
- Emotions
- Cognitive abilities (such as thinking, reasoning, judgment, imagining, and memory).

Though these changes in behavior and cognitive abilities result from brain changes, changes in a person's behavior or cognition are often mistakenly viewed as intentional or manipulative. For example, this person may mistakenly be seen as stubborn, "mean", ornery, or lazy.

## ALZHEIMER'S DISEASE AND THE BRAIN

There are many **changes** in the **brain** with Alzheimer's Disease. Five of these **neuropathological** changes are: atrophy, beta-amyloid plaques, tau tangles, inflammation, and neurochemical changes.

1. **Atrophy** is the **reduction in size** of a structure. Atrophy due to death of nerve cells in Alzheimer's Disease causes much of the confusion and change in cognitive abilities. Atrophy occurs with normal aging, but is especially pronounced and is pathological in Alzheimer's Disease. The atrophy is visible on a computed tomography (CT) scan, a magnetic resonance imaging (MRI) scan, or at autopsy. Terms such as "widened sulci", "narrowed gyri", and "enlarged ventricles" refer to evidence of atrophy, that is, loss of brain tissue (nerve cells) in identified locations.
2. **Beta-amyloid plaques** are little patches or collections of debris located **outside of nerve cells** in the brain. A protein called beta-amyloid is a primary component of the plaques. The number of beta-amyloid plaques generally correlates with a person's performance on cognitive tests (such as neuropsychological tests).
3. **Tau tangles** are **inside nerve cells** in the brain. They are collections of a protein called tau that begins to act abnormally to disrupt the transport of cell nutrients within the nerve cell, contributing to the cell's death. The number of tau tangles also generally correlates with a person's performance on various cognitive tests (such as neuropsychological tests).

4. **Inflammation** occurs when the microglia (the immune system cells in the brain) **cannot keep up** with the **removal** of the **toxic proteins** (including the beta-amyloid and tau) and debris (from dead and dying nerve cells) from the brain.
5. **Neurochemicals** (or neurotransmitters) facilitate the process of communication between nerve cells (that is, neurons), so essential to the brain's maintenance and functioning. A neurotransmitter is released from a nerve cell into the gap between it and another nerve cell. There are many types of neurotransmitters. There is a **reduction** in the **amount** of some of these neurotransmitters, including a neurotransmitter called acetylcholine. Some of the medications that treat the symptoms of AD inhibit acetylcholinesterase (which breaks down the acetylcholine) This allows more acetylcholine to remain in the brain.

## **BRAIN CHANGES IN DEMENTIA**

In dementia, changes to the brain generally occur in **both hemispheres** and in **all** three of the **lobes** discussed in this handout. (They occur in other parts of the brain not discussed here, as well.)

The changes do not occur all at once, but **gradually spread** across the brain as the dementia progresses from its early stages to the middle stages and then the advanced stages. As each lobe is affected by the changes, there is also a **gradual increase** in **severity** or amount of change within that lobe, even as the brain changes are beginning to spread to other lobes. For example, in Alzheimer's Disease, the plaques and tangles will likely begin near and in the hippocampus just behind the temporal lobe. The hippocampus is associated with memory. So, memory is one of the first symptoms (that we easily notice) of Alzheimer's disease. Then they may begin to spread to the parietal lobe and a little into the frontal lobe. But as they spread to the parietal lobe and frontal lobe, they are increasing in number in the hippocampus. So, this person's memory continues to get worse as the dementia progresses over time.

As a result, the change in cognitive abilities is usually gradual and progressive. This is in contrast to most major strokes, where one hemisphere is primarily affected and a significant amount of brain change occurs suddenly and all at once.

The progression of the changes across the brain in dementia, and the order in which the lobes are affected, depend upon the type of disorder causing the dementia.

The spread and increase in severity of the changes across the brain, cause the dementia to progress through **stages** commonly experienced.

## **BRAIN CHANGES AND COGNITIVE ABILITIES IN DEMENTIA**

When one lobe or area of the brain changes, the functioning of the **whole brain** is affected. But the cognitive abilities in which the changed lobe or area play a major role are particularly affected.

As any person ages from birth to old age, each lobe and hemisphere becomes increasingly associated with and **specialized** in specific cognitive abilities.

When part of the brain changes, the rest of the brain tries to take over the functions the changed part had been performing (that is, the cognitive abilities associated with that changed part of the brain). The older the brain is, the more specialized each lobe and hemisphere has become and, therefore, the **more difficult** it is for other parts of the brain to take over the performance of the affected cognitive functions.

In disorders of dementia such as Alzheimer's Disease, while repair mechanisms may be at work, the attempts of other parts of the brain to perform the functions lost when each part is affected, can't keep up with the speed with which the brain changes spread to various parts of the brain. So, the result is an overall decline in the brain's ability to perform cognitive functions. In less progressive disorders, such as



major strokes, even brains that are older might recover some functions more easily.

## **COGNITIVE CHANGES IN DEMENTIA**

In Alzheimer's Disease evidence of the changes in the brain (that is, the changes in cognitive abilities) may become apparent as each lobe becomes significantly affected by the brain changes.

The **amount of change** required in each lobe to create noticeable cognitive and behavioral changes depends upon the **individual** brain, person, and circumstances.

Many of the changes seen in behavior and in the ability to perform daily tasks are caused by the changes in cognitive abilities that result from changes to the frontal, temporal, and parietal lobes. Examples of these cognitive and behavior changes are listed in this handout. Whether the changes in each lobe are caused by dementia or other disorders, the cognitive abilities affected are the **same**.

As the brain changes spread to and multiply in each lobe the effects are very specific to the cognitive abilities associated with that lobe. Thus, as each lobe changes, a new set of cognitive abilities changes and increasingly changes as the disease progresses.

To the extent the spread of brain changes and the rate of increase in severity of change in each lobe are similar among individuals, the individuals will pass through **similar stages** during the course of the dementing disorder, though with **individual variation**.

## **PROGRESSION OF COGNITIVE CHANGES**

Cognitive abilities in dementia are always gradually changing because the brain changes are always gradually spreading and increasing in severity.

Not only is the general **change in cognition** gradual, but **each cognitive ability** itself also changes gradually. (The numbers below simply indicate an order, not specific stages.)

1. First there are isolated instances of evidence of change. For example, one day this person forgets how to get home from the store.
2. Then instances of this change become more frequent. For example, the frequency with which this person gets lost coming home from the store increases.
3. This cognitive change continues to increase in frequency and severity. For example, this person frequently gets lost and increasingly has difficulty recognizing their disorientation and knowing how to get help.
4. The frequency and severity continue to increase as another cognitive change begins to appear in isolated instances and gradually increases in frequency and severity. For example, this person continues to get lost more and more often, but now has difficulty producing the words they want to use when they see someone who might be able to help them.
5. Each cognitive ability continues to increase in severity and frequency; it does not stay at the same level as other cognitive abilities change.

## **CONCLUSION**

The changes in cognitive abilities resulting from changes in the brain, occur as the lobe associated with each cognitive ability changes. The particular order and severity of change in each lobe of the brain and associated cognitive abilities vary with each individual person, and (if there is an injury or disorder) the nature of the injury or disorder or type of dementia this person is living with.

## **For more information**

1. The Michigan website called Improving MI Practices at <https://www.improvingmipractices.org> has updates and many additional handouts and resources, including **all of these CAIS handouts** (43 total), the

Cognitive Abilities and Intervention Strategies (CAIS) **Questions to Ask** and the **CAIS Intervention Strategies**, **CAIS** information and background **resources**, and the **Caring Sheets**:Thoughts and Suggestions for Caring that are a part of the Michigan Dementia Care Series.

2. Mace, N., Coons, D., Weaverdyck, SE. (2005) Teaching Dementia Care: Skill and Understanding. Baltimore, Md.: Johns Hopkins University Press.

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3. Weaverdyck, S.E. (1991) “Assessment as a Basis for Intervention” and “Intervention to Address Dementia as a Cognitive Disorder”. Chapters 12 & 13 in D. Coons (Ed.) Specialized Dementia Care Units. Baltimore, Md.: Johns Hopkins University Press.
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### **Dementia Care Series**

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All Caring Sheets are available online at the following websites: [http://www.michigan.gov/mdhhs/0,5885,7-339-71550\\_2941\\_4868\\_38495\\_38498---,00.html](http://www.michigan.gov/mdhhs/0,5885,7-339-71550_2941_4868_38495_38498---,00.html) (Michigan Department of Health and Human Services MDHHS), at <http://www.lcc.edu/mhap> (Mental Health and Aging Project (MHAP) of Michigan at Lansing Community College in Lansing, Michigan), and at <https://www.improvingmipractices.org> (Michigan Improving MI Practices website)

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