



DEMENTIA CARE SERIES

Michigan Department of Community Health

THOUGHTS & SUGGESTIONS FOR CARING

Caring Sheet #2: Brain Changes and the Effects on Cognition

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Introduction

This caring sheet describes the brain changes in dementia and the impact these changes have on cognition. It is the change in cognition (i.e., the way in which a person thinks and processes information) that leads to changes in behavior and the ability to perform tasks.

Caring sheet #1 outlines the organization of the healthy brain and cognitive functions.

These two caring sheets (#1 and #2) are written as companion pieces with corresponding lists of intact and impaired cognitive functions. Other caring sheets address intervention strategies to address these cognitive changes.

Dementia

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

Some brain changes in older adults can be **temporary** and **treatable** (e.g., delirium) if they are caused by treatable disorders such as:

- urinary tract infection
- vitamin deficiency
- constipation
- flu
- depression
- reactions to medications
- dehydration
- pain



Other brain changes are currently **irreversible** and **progressive** (i.e., increasingly severe) if they are caused by disorders such as:

- Alzheimer's Disease
- Vascular Dementia
- Dementia with Lewy Bodies
- Frontotemporal Dementia
- Creutzfeldt-Jakob Disease

This caring sheet describes the currently irreversible, progressive brain changes and the resulting cognitive impairment.

Sometimes both temporary and irreversible changes occur simultaneously. When the disorder causing the temporary changes is treated immediately, the person usually returns to the level of cognitive functioning caused by 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 the person's:

- behavior
- personality
- cognitive skills (such as reasoning, judgment, and memory).

Though these changes in behavior and cognition result from brain damage, they are often mistakenly viewed as intentional or manipulative.

Alzheimer's Disease

In Alzheimer's Disease there are four hallmark pathological changes to the brain: atrophy, neuritic plaques, neurofibrillary tangles, and neurochemical changes.

- **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 cognitive impairment. Atrophy occurs with normal aging, but is especially pronounced and is pathological in Alzheimer's Disease. The atrophy is visible on a CAT scan and at autopsy.



- **Neuritic plaques** are little patches or collections of debris in the brain. They are located outside of nerve cells. A protein called amyloid is at the core of the plaques. The number of neuritic plaques correlates with a person's performance on cognitive tests (such as Intelligence or IQ tests).
- **Neurofibrillary tangles** are inside nerve cells, particularly in the axons of nerve cells. Axons are the protrusions from the nerve cell body, which carry information from one nerve cell to the next. Tiny neurofibrils (filaments or tubules) transport cell nutrients within the nerve cell. The neurofibrils become tangled in a very characteristic way (double helical) and therefore disrupt the cell maintenance processes, probably contributing to the cell's death. The number of neurofibrillary tangles also correlates with a person's performance on various cognitive tests.
- **Neurochemical** changes also occur in Alzheimer's Disease. There is a reduction in some of the neurotransmitters. Neurotransmitters (the chemical messengers) are neurochemicals which are transferred from one nerve cell to another as a method of communication with that nerve cell. This intercellular communication is essential to the brain's maintenance and functioning. There are many different kinds of neurotransmitters. One, which is particularly reduced in amount in Alzheimer's Disease, is called acetylcholine.

Vascular Dementia

In Vascular Dementia, the brain has many tiny strokes on the cortex or surface of the brain. Spots of softened dead tissue (lesions) occur throughout the cortex. These lesions can be seen on a CAT scan, but not always. A CAT scan can rule out the possibility of a major stroke as a source of the cognitive impairment.



The Brain

The occurrence of these pathological changes in specific parts of the brain directly correlate with changes in specific cognitive functions.

The structure of the brain and organization of its cognitive functions was described in Caring Sheet #1.

The focus of that sheet (and of this sheet) is the **cortex**, the bark or 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.

Caring sheet #1 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.)

Caring sheet #1 noted that each lobe and hemisphere has its own set of cognitive functions in which it plays a major role. It listed some of those functions.

The damage in the frontal, temporal, and parietal lobes in the cortex are particularly related to the impairment in dementia of the cognitive functions listed there. (Other important impairments result from damage to a fourth lobe, the occipital lobe including an impaired ability to recognize objects and faces, and to see more than one object at a time.)

Individualized Brain Organization

It is important to note that the lobes overlap and interact in the control of cognitive functions, and that they communicate with each other in ways somewhat idiosyncratic to each individual person.

This listing of specific cognitive functions as the province of each lobe, therefore, is an oversimplification and generalization, though there is clearly a strong correlation between damage to specific lobes and corresponding impairment in specific cognitive functions.

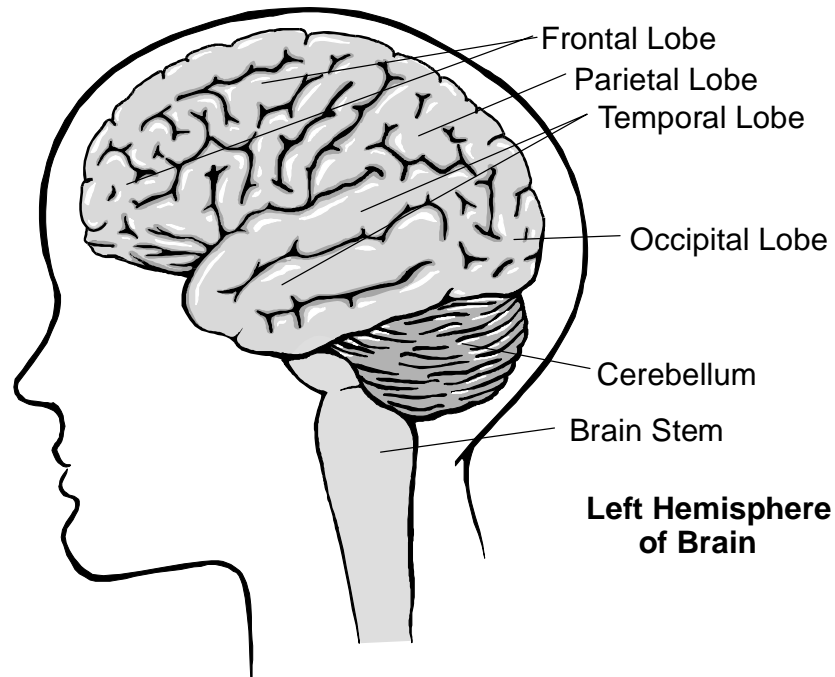


Figure 1: Schematic drawing of the brain, including the left cerebral hemisphere, cerebellum and brain stem. *Size and position of the brain with respect to the outline of the head is not to scale. The right side of the brain is essentially a mirror image of the left. The right cerebral hemisphere has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

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

Brain Damage in Dementia

In dementia, the pathological changes to the brain described above (the atrophy, neuritic plaques, neurofibrillary tangles and neurochemical



changes) occur in both hemispheres and in all three of the lobes discussed here. (They occur in other parts of the brain not discussed here, as well.)

The pathological changes do not occur all at once, but gradually spread across the brain. As each lobe is affected by the pathological changes, there is also a gradual increase in severity or amount of pathological change within that lobe, even as it is beginning to spread to other lobes. As a result, the change in cognition or dementia is usually gradual and progressive. This is in contrast to most major strokes, where one hemisphere is primarily affected and the brain damage occurs suddenly and all at once.

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

The spread and increase in severity of the pathological changes across the brain, causes the dementia to progress through stages commonly seen by caregivers.

Brain Damage & Cognition in General

When one lobe or area of the brain is damaged, the functioning of the whole brain is affected, but the cognitive functions in which the damaged area or lobe play a major role are particularly impaired.

As a person ages from birth to old age, each lobe and hemisphere becomes increasingly specialized in the cognitive functions it performs.

When part of the brain is damaged, the rest of the brain tries to take over the functions the damaged part had been mediating. The older the brain is, the more specialized each lobe and hemisphere is, and the more difficult it is for other parts of the brain to recover the affected functions.

In dementing disorders such as Alzheimer's Disease, while repair mechanisms may be at work, the pathological changes appear to spread more quickly than the ability of the other parts of the brain to recover the lost functions. In less progressive disorders, such as major strokes, even brains that are quite advanced in age, seem to recover functions more easily.



Cognitive Changes in Dementia Resulting from The Brain Changes

In both Alzheimer's Disease and Vascular Dementia, evidence of the pathology (i.e., the signs and symptoms of cognitive impairment) may become apparent as each lobe becomes significantly affected by the pathology.

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

Many of the changes seen in behavior and in the ability to perform daily tasks are directly caused by the cognitive changes that result from the pathological damage to the frontal, temporal, and parietal lobes.

As the pathology spreads to and multiplies in each lobe the effects are very specific to the cognitive functions mediated by that lobe. Thus, as each lobe becomes damaged by the pathology, a new set of cognitive functions becomes impaired and becomes increasingly impaired as the disease progresses.

To the extent the spread of pathology and its rate of increase in severity in each lobe is similar among individuals, the individuals will pass through similar stages during the course of the dementing disorder, though with some individual variation.

Progression of Cognitive Impairment

Cognitive abilities are always gradually changing because the pathology is always gradually spreading and increasing in severity.

Not only is the general change in cognition gradual, but each cognitive function, itself also becomes impaired gradually.

- First there are isolated instances of symptoms (e.g., the person forgets how to get home from the store one day).
- Then instances of this impairment become more frequent (e.g., the frequency with which the person gets lost coming home from the store increases).



- This cognitive impairment continues to increase in frequency and severity (e.g., the person frequently gets lost and increasingly has difficulty recognizing her disorientation and knowing how to get help).
- The frequency and severity continues to increase as another cognitive impairment begins to appear in isolated instances and gradually increases in frequency and severity.
- Each cognitive function continues to increase in severity and frequency; it does not stay at the same level as other cognitive functions change.

Cognitive Impairment & Parts of the Brain

The impaired cognitive functions listed here correspond to the intact cognitive functions listed in Caring Sheet #1.

Left Hemisphere (for most right handed people)

When a person's left hemisphere is damaged:

- the right side of the body tends to be weaker or unable to move.
- the right side of the body may be altered in its ability to feel, notice, or recognize stimuli.
- the person may also have slurred speech or difficulty finding the words she wants to use.

Right Hemisphere (for most right handed people)

When the right hemisphere is damaged:

- the left side of the body tends to be weaker or unable to move.
- the left side of the body may be altered in its ability to feel, notice, or recognize stimuli.
- the person may have difficulty locating objects in space or judging distances. An environment with many objects or much movement can be very upsetting or fatiguing for this person.



Frontal Lobe Impairment

As the frontal lobe becomes affected cognitive symptoms become evident. The person may have difficulty:

- problem solving and planning a task.
- thinking of ideas for conversation, of activities to relieve boredom, or of possible explanations for an event (e.g., the only explanation for odd tasting water is that you're poisoning me).
- recognizing when she is done with a task such as eating a meal.
- initiating a task (e.g., a person may sit in front of a lunch plate and start eating only when another person initiates the process for her; she may appear lethargic or uninterested).
- recognizing or correcting mistakes in social protocol (e.g., will pinch a caregiver's breast, and laugh about it, but not recognize the extent to which the action was inappropriate; or might take a blouse off because she's hot even though she is in the living room).
- knowing how much time has passed (e.g., may sit down to eat and then get up and walk away after a few bites; or may ask when dinner is twenty times in three minutes, because she thought perhaps a half hour had passed since she had last asked).
- understanding the sequence of events in past or present time (e.g., understanding why the fact that she is 90 years old and her children are in their 50s and 60s means that she does not need to go home to feed her children).
- recognizing the depth of his own emotion or even that he is angry, sad, or upset; as well as difficulty in recognizing what he knows (e.g., he may know which chair he always sits in for lunch, but may say he doesn't know, even as he walks to the chair on his own and sits down.) The ability to consciously monitor and "watch" oneself is impaired.
- analyzing why she is feeling an emotion (e.g., she may say she wants to go home, but in fact she is anxious and cannot think of any other reason for her anxiety).
- thinking twice before acting or saying what comes to her mind (e.g., she may swear or say "She's fat" about someone walking by).



- adapting to new situations or conditions. She may feel anxious or be unable to do a task in unfamiliar surroundings or with unfamiliar task objects (e.g., she may have difficulty brushing her teeth with pump toothpaste instead of tube toothpaste, or changing morning routines and bath times from past habits). She is most relaxed and can perform tasks most successfully when the caregiver is consistent and conditions are as they were throughout most of her adult life.
- changing from one thought or activity to another. (e.g., when he is privately reminiscing about a game of baseball from the remote past, it is difficult for him to quickly attend and recognize someone walking by saying “hi” or asking him to take some medication.)
- creating a picture in her mind of an object in order to understand or recall what someone is saying (e.g., choosing between two food options that are not in front of her; or recognizing that a clear glass has water in it when the water seems invisible).
- conceptualizing the order of task steps or items (e.g., the order of clothes to put on).
- thinking about or doing more than one thing at a time (e.g., feeling embarrassed about a behavior and changing the behavior).

Temporal Lobe Impairment

As the temporal lobe becomes affected other cognitive symptoms become evident. The person may have difficulty:

- understanding the words another person is using.
- producing the words he wants to use.
- remembering what she told someone two minutes ago.

Parietal Lobe Impairment

As the parietal lobe becomes affected additional cognitive symptoms become evident. The person may have difficulty:

- recognizing where objects or people are in the environment, particularly when they are moving.



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- performing tasks which require manipulation of objects or of his own body, particularly in relation to other objects (e.g., dressing, setting the table or navigating large spaces).
- performing simple arithmetic calculations.
- responding to a request to walk or to move a part of her body.

As was said above, the changes in cognition resulting from pathology of each of these lobes in the brain, occur as the lobe responsible for each function becomes damaged. The particular order and severity of each function varies with each individual person with dementia.

Other caring sheets suggest interventions that address these cognitive changes. For a summary of information and possible intervention strategies for specific disorders, see Caring sheets #11 about Alzheimer's Disease, #12 about Dementia with Lewy Bodies, and #13 about Frontotemporal Dementia.

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All caring sheets are available online at the following two websites: <http://www.lcc.edu/mhap> (Mental Health and Aging Project (MHAP) of Michigan at Lansing Community College in Lansing, Michigan) and <http://www.dementiacoalition.org> (Michigan Dementia Coalition in Lansing, Michigan).

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