Chapter 2: You Can Understand Brain Functioning: Neurobiology 101

Introduction

Unless you already have a good working knowledge of how the brain works, do not skip this chapter. Your own brain may worry that this will be a mind-numbing topic, but the basics are actually quite easy to understand—if you don't worry about every detail. It's like technology: you don't need to know exactly how the internet and all of its server connections work behind the scenes, but you do need to be familiar with some basic ideas to read your email or use a search engine to its fullest capability.

Similarly, the brain is an enormously complex organ, but understanding it will improve your ability to recognize, approach, and work with FASD behaviors—and an FASD brain—more intelligently. There are four concepts discussed in this chapter:

(1) The brain is made of many parts that work together.

(2) The brain is supposed to develop perfectly, but drinking while pregnant damages brain structures and the connections among them permanently.

(3) The FASD brain is everlastingly thrown off-kilter, which results in concrete thinking, poor decisions, and problem behaviors throughout life.

(4) The key mistake that people make with FASD is to ignore or forget about the brain damage. They focus only on changing inappropriate behaviors, rather than helping the damaged brain function better. They literally believe that a person with FASD is either choosing to misbehave or not trying hard enough, even though the brain is damaged. This is critical: A damaged brain will not function normally. Period.

However, nobody needs to be a neuroscientist to understand the brain damage of FASD, so this discussion will be more like a "cartoon," rather than a documentary. I'll go over all you need to know in a logical, step-by-step process that will increase your awareness of why and how FASD affects an individual in the unpredictable ways it does. The discussion is grounded in understandable concepts, metaphors, and language that I use with patients every day. Just keep in mind that literal brain functioning is a far more intricate web of both known and unknown processes than what we'll need to cover here, but if you want more detailed or specific information, there are several excellent references listed in Appendix R [readings].

Incidentally, because the brain *is* so complex and intricate, it can demonstrate either great resiliency (e.g., the victim of a mild stroke "relearning" to walk) or extreme vulnerability (e.g., a head injury that results in an inability to concentrate or pay attention), depending on the severity and location of damage in the brain. And even though prenatal alcohol exposure kills brain cells, prunes dendrites and malforms brain structures in utero, there are positive steps that can be taken from knowing how the brain is *supposed* to function—then, we can better understand a person when her brain is *not* functioning normally due to FASD.

The Brain is Made of Many Parts

Neurons. The brain is composed of two main types of cells: glial cells and neurons. To understand human behavior and FASD, all we really need to focus on is the **neurons**, since those are the cells that allow us to learn, do, and know everything. While **glial cells** (and others) are vitally important and actually more numerous, their job is to support the smooth functioning and maintenance of the 100 billion neurons in a typical brain. Neurons constantly send and receive signals to each other within the brain and the rest of the nervous system, which allows a person to learn, do, and know everything that she's capable of. Each of the 100 billion neurons has at least one axon with terminals, which send or transmit a signal, and many more dendrites, which receive a signal. Here is a drawing of a neuron:

> The brain is composed of 100 billion **neurons**, the "gray matter" of the brain that allows us to do, know, and learn everything.

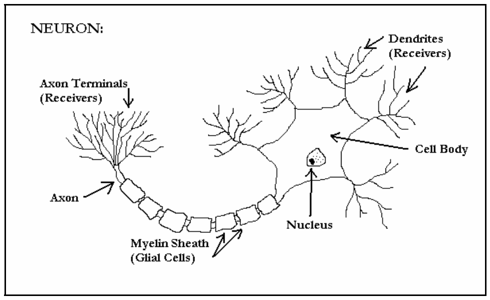

Figure 1: Neuron

Neurons have other physical parts to them, but you don't have to know much about these to understand basic brain functioning—just be aware that neurons are very complex. As a short summary though, the myelin sheath (a form of glial cells) grows around each axon and improves signal transmission from the dendrites and cell body to the axon terminals. Myelin continues to grow and develop well into a person's 20s, and it helps with speeding up the neurons' signals, which actually promotes the ability to learn. Each neuron also has a nucleus, which contains DNA, mitochondria and elements that most all living cells have in common. Of course, a great deal of every living cell, including neurons, is made of water. This is why we cannot go long without water and why hydration is so important for clear thinking.

Synapses. While the brain has 100 billion neurons, none exactly touch each other, which is different than most other cells in our bodies. There are trillions of microscopic spaces between every axon terminal and every dendrite of every neuron. These tiny spaces are called **synapses**, and they are thought to be one of the most important aspects of learning and memory (*The Synaptic Self* is a great reference book on synapses). The synapses are the points at which each neuron communicate with another neuron. New synapses form when we learn something new, or they can diminish in number from disuse; hence the familiar saying, "use it or lose it."

Synapses are the trillions of tiny spaces between neurons' dendrites and axon terminals filled with cerebral (brain) fluid.

Neurotransmitters. For a neuron to signal another neuron, its axon excretes a tiny amount of chemical, called a **neurotransmitter**. There are several types of neuro-transmitter (e.g., dopamine, acetylcholine, serotonin, etc.) produced by neurons. Particular neurotransmitters are associated with various types of communication among neurons. For instance, dopamine and acetylcholine are key neurotransmitters for muscle control; people with movement disorders, like Parkinson's disease, typically have the wrong balance of these two neurotransmitters in their body.

Neurotransmitters are chemicals produced by neurons to activate and communicate with each other.

For the purposes of discussing FASD, it isn't really important which kind of neurotransmitters are involved, only that once a neurotransmitter is excreted from an axon, it floats around in the tiny synapse, waiting to be received by a dendrite (or even an axon, which can monitor the proper amount of neurotransmitter it is excreting). After a dendrite absorbs a neurotransmitter, it is activated or "excited" because it has received a signal, which it then passes along to another neuron through its own axon. (In some cases, neuro-transmitters can also inhibit, or "turn off," a neuron or signal pathway.)

Hard-Wired Brain Circuits. We'll call the path of this signal through a series of neurons a "**brain circuit**." It isn't really a circuit in the traditional sense, but a pathway of activation leading to a behavior, thought, emotion, or an internal experience. Neurons are organized into brain circuits for particular purposes and functions that we or our body needs to accomplish. Some brain circuits are "hard-wired" at birth with a genetically preset function. These regulate automatic body functions (e.g., body temperature), bring in and interpret sensory information (e.g., the five senses), make some emotions possible, and support other important functions in being carried out. It makes a great deal of sense for these to be in place and working at birth. For

A **brain circuit** is a group of neurons in a pathway that communicates together on a regular basis for a particular purpose.

Some brain circuits are **hard-wired** before birth into specific brain structures (for survival instincts) or else predisposed to specific functions (like language).

instance, we can't afford to learn by trial and error what the optimal temperature for our bodies must be or, later on, constantly have to think about whether we should be sweating or not to keep our body at the correct internal temperature. Hard-wired brain circuits are genetically set to maintain it at 98.8 degrees, because that is the point at which our metabolism and bodily functions work most effectively. If this set point were too easy to change, then we could die by neglecting to think about it or experimenting with wrong temperatures.

Learned Brain Circuits. Other brain circuits develop from repeated or intense activation from either a repeated or intense experience. These circuits may be genetically predisposed for a general purpose (e.g., motor skills or verbal memory), but they require repeated and/or intensive learning experiences to learn their specific purpose. These circuits become strengthened and more "permanent" because each neuron in the circuit grows more dendrites and axon terminals (and therefore, synapses) based on the specific experience activating them. The brain circuit is then more likely to be used, activated, or "remembered" in the future because it now holds information specific to that experience in its synapses. This is how memory, habits, and beliefs form: repeated and/or intense stimulation physically adds more synapses within a brain circuit and improves how it communicates and works together with other brain circuits. The strengthened circuits can then be used together and will be activated again under the same or similar situations, rather than having to form a new circuit connection for every experience.

> Other brain circuits **develop** as a result of experiences after birth. A new circuit can form from repeated experience (like memorizing numbers) or an intense experience (like pain).

Learning from repeated experience. A cartoon example of a new brain circuit forming from a repeated experience would be saying a telephone number over and over to yourself until you have it memorized. In this case, a circuit in the memory section of your brain is repeatedly activated until enough new synapses are formed to hold the numbers in your memory. The more you say it (i.e., activate the new brain circuit), the stronger the connections in that circuit (i.e., more synapses created), and the better your memory for that number (i.e., you can access a stronger brain circuit quicker and more easily than a weaker one). Forgetfulness of the telephone number could be a result from the circuit weakening due to disuse or lack of activation (although there are other reasons why this could happen as well, some of which will explain why individuals with FASD often have unpredictable memory skills).

Learning from an intense experience. A cartoon example of a new brain circuit forming from an intense experience would be learning that a hot stove should not be touched. Physical pain from the heat of a stove creates an intense activation of brain circuits because pain sensors in the skin trigger a huge release of neurotransmitters to get the brain's full attention. The intense activation tells the brain that there is something very important to do now and to remember for the future (in this case, avoiding pain). The intense increase in neurotransmitters causes extra synapses to develop almost immediately, which strengthens the brain circuit, makes the memory vivid, and helps us learn our lesson in a single experience that can now be applied immediately—no practice necessary (or wanted). This type of learning is also important because it simply wouldn't be evolutionarily safe to need seven or eight hot stove experiences before firmly learning that they should not be touched.

Learning from hard-wired circuits. In this particular case, we also have a situation in which the new brain circuit (a rule or memory to "avoid touching hot stoves because it will create pain") stemmed from an already existing hard-wired circuit. The ability to feel pain, in this case a burned finger, is hard-wired into virtually everyone. It is an automatic, instinctual reaction that protects us from harm and is part of a person's fight or flight response, sometimes called an "**acute stress response**." As we grow, many new brain circuits are developed as a result of an acute stress response and desiring to avoid some kind of stress, thus creating rules and memories to keep us safe.

An **acute stress response** is triggered by fear, pain, or danger (stressors). It's a hard-wired response to makes us more likely to keep ourselves safe through the "fight or flight syndrome."

On the other hand, new brain circuits can also develop from already existing hard-wired circuits that make a person feel good. If a pleasurable brain circuit is activated during the course of some new action (which then activates a new brain circuit), then that particular behavior will also be remembered and probably used again in the future. A simple example of this would be tasting food with sugar in it and finding it pleasurable. Sweetened foods generally taste good to people, and such foods tend to have lots of carbohydrates for quick energy that would have helped a person to survive in the past. Nowadays, we aren't chased and eaten by wild animals as often, so this instinctual pleasure isn't as critical to survival as it once was, and it can go awry if we overindulge, creating obesity and disease.

The Parts of the Brain Work Together. There are two key concepts of brain functioning to take from these examples. The first concept is that there are different types of brain circuits organized together for different purposes. Some are instinctual or regulate bodily processes and some are predisposed toward emotions, motor control, higher-level types of knowledge and behavior, etc. Often, brain circuits with similar or related purposes are grouped together or near each other in the brain so they can communicate faster and work together more effectively. Some are commonly referred to as "centers," such as the pleasure center or a language center of the brain. Others are specific structures with specific jobs within the brain, such as the amygdala, which, among other things, helps us make the connection between the effect of an acute stress response (e.g., a burning pain) and its cause in the environment (e.g., a hot stove).

The second concept is that brain circuits, centers, and structures are organized to regularly communicate with each other and thus activate and create new brain circuits. The amygdala is a good example in which this occurs. In cartoon explanation, the amygdala receives signals from the visual, auditory, and somatosensory (touch, pressure, temperature, pain, body position, etc.) centers and decides if what we are seeing, hearing and/or feeling is dangerous or not. If the amygdala decides things could be dangerous, then it sends warning signals (neurotransmitters) to the hypothalamus, another brain structure, so that the hypothalamus will signal heart rate, blood pressure, and adrenaline levels to rise, preparing our bodies for an appropriate acute stress response—either fight or flight.

For a reality check, the amygdala also signals our higher-level thinking centers so we can consciously decide on an action—in the event it were more appropriate to cope with what's going on, rather than strictly fight or flee. When seeing a poisonous snake in the wild, many people would experience fear because the amygdala determined danger to be present and the higher brain centers agree with the amygdala's assessment. In that case, people would tend to move away from the snake, using a flight response, rather than fight. On the other hand, when seeing a similarly poisonous snake in a zoo, some people may still experience fear because of the amygdala—snakes are still a danger—but the higher brain centers could override the flight response because they assume, based on experience and knowledge, that the snake will

> The **amygdala**, like many structures in the brain, is critical in linking together our conscious and subconscious experiences.

remain properly caged. That is, the snake is not dangerous unless it escapes its cage, in which case the amygdala would strongly insist on a flight response (and the higher brain centers would probably agree).

Finally, all the brain circuits, centers and structures are also grouped physically within the brain, somewhat according to their basic type of function or purpose. Here again, it isn't necessary to know or remember all the details—nobody knows all of the brain's functions or how they work because there are so many components and so much complexity. However, I'll briefly highlight several important areas of the brain to illustrate the complex, interrelated nature of the brain's circuits and structures. All you really need to know is that the various areas of the brain are organized to communicate with each other in an effective, systematic way via brain circuits formed by the neurons.

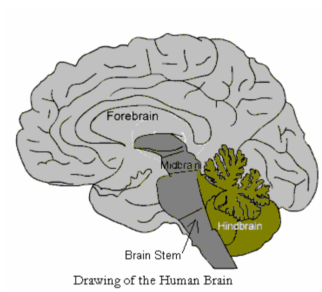

Figure 2: Diagram of Brain

Important Brain Areas. Here are a few brain areas to at least be aware of:

- **Forebrain** – This is the largest part of the brain and the last area to fully develop. It is composed of four primary lobes that make up the cerebrum and cortex (where higher-level functions take place), as well as the limbic system, basal ganglia, the medial forebrain bundle, and other important smaller structures. Any part of the forebrain is extremely susceptible to damage from prenatal alcohol exposure, including:

- **Frontal Lobe** – This is where higher-level thought, decision-making, foresight, and planning are located. These are often called "executive functions," similar to a business executive making decisions for a company. Frontal lobe structures are able to consciously inhibit or redirect impulses and instincts. They are also involved in mapping out and planning how our bodies move, as well as our ability to express ourselves through language. A normal frontal lobe continues to learn and adapt throughout life, but it is often adversely affected by FASD, creating poor decisions, impulsivity, and sometimes clumsiness.
- **Parietal Lobe** – A great deal of general information is received and processed by the parietal lobe, such as processing facial expressions, but also body sensations such as touch and pressure. Spatial orientation (i.e., mentally representing one's environment and directionality) is also handled here.
- **Temporal Lobe** – This area controls auditory processing, understanding spoken language, and many memory functions.
- **Occipital lobe** – This is where visual processing takes place.
- **Limbic System** – Several very important structures here are involved with emotions, emotional processing, learning, and memory functions.
- **Basal Ganglia** – Structures in the basal ganglia work with the frontal lobe to control voluntary motor abilities.
- **Medial Forebrain Bundle** – This is where the pleasure center is located and is also involved with additions, "runners' high," and other pleasurable activities.

- **Cerebellum/Hindbrain** – These structures control balance and coordination, store learned movements (e.g., riding a bike), and refine motor movements. An important associated structure is the:

- **Reticular Activating System** – Between the fore- and hindbrain regions, this one regulates sleep and arousal levels. It also directs attention to new or unexpected sensations (e.g., background noise, pressure on the skin, a loud, unexpected noise, etc.), coordinates with the amygdala to determine if the sensation is a threat, and then, if no threat exists, allows us to habituate to, or ignore, the sensation.

- **Brain stem** – These structures mostly regulate autonomic life functions (e.g., breathing, heart rate, etc.) and some reflexes, including:
  - **Midbrain** – A relatively small brain area that is part of the brain stem and controls eye movements as well as visual and auditory reflexes.
  - **Medulla** – A part of the brain stem involved with changing our autonomic responses during an acute stress response, creating some of the sensations of fear. While these are hard-wired circuits, they can be consciously influenced to some degree through biofeedback, hypnosis or relaxation techniques (e.g., deep breathing, yoga, etc.). However, they are mostly automatic and difficult to change through conscious desire, psychotherapy, or other direct means.

All you really need to know about the brain so far:

1. The brain is composed of 100 billion neurons, which form "brain circuits" that allow humans to learn, know, and do everything
2. Some brain circuits are "hard-wired" and others develop from either repeated or intense experiences
3. Brain circuits with similar functions are grouped together in areas, centers, and structures within the brain
4. Brain circuits, centers and structures communicate among each other

5. The brain is very complex, but basic functioning can be understood

The Brain Develops

Now, you may well know this, and I have certainly implied it earlier, but just to be explicit: the brain is an amazing organ that develops over time. This is an important concept that we may not often think about deeply, but the implications of it are important to the normal functioning of a normal brain, and therefore the normal behavior of an individual, as well as the abnormal functioning of a brain damaged by prenatal exposure to alcohol and the consequent abnormal behavior of an individual with FASD. This is often a very complex, poorly understood process, but here are the basics for you to know.

Normal Development. Neurons begin to develop soon after conception, and the beginnings of an elementary nervous system (the "neural plate") are apparent by day 16 after conception. By the seventh week of gestation, the brain has formed its main sections (forebrain, midbrain, hindbrain, brain stem, and also the spinal cord), and experts estimate that up to 250,000 neurons per minute are formed at various points during gestation as the brain grows and develops. After these new neurons form, they then travel, or "migrate," outward and establish the structures and outer layers of the brain. This process itself is genetic (hard-wired), and not fully understood, but we do know that neurons migrate along glial cells, using special chemicals to mark out and follow their correct pathways. Neuron migration is an important factor in the brain damage of FASD, as prenatal alcohol exposure can alter or impair the migration process, leaving garbled circuits with weak or missing links to other brain circuits.

> After forming, neurons **migrate** outward all through the brain into predetermined locations to form the brain circuits and structures needed for human functions.

Once in place, the neurons have formed their predetermined brain circuits and structures, as well as the connections for communication (also brain circuits) among them.

Of course, some of these circuits and structures have predetermined purposes and functions (such as the amygdala) that are hard wired by genes, while others are in place and ready to "learn" from the environment or one's experience. If we use computers as an example, the brain also has preprogrammed memory circuits, processors, video cards and so on, but much of the actual content is installed later via software downloads, surfing the internet, etc.

A simple way to envision this is by thinking of the brain's circuits and structures organized into an orderly system that promotes effective communication among the structures. This allows normal behaviors, emotional functioning, and logical thought processes. A "cartoon image" of this could be represented by Figure 3:

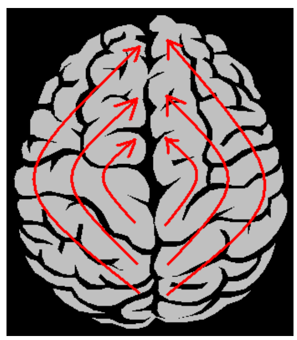

Figure 3: Normal Brain with Properly Developed Circuits

In a normal brain, the brain circuits, represented by the lines and arrows, are organized and orderly, allowing effective communication among the circuits and, therefore, normal or typical human functioning.

<u>More you need to know</u>:

1. Millions of neurons develop and then migrate outward, forming the circuits and structures of the brain
2. Brain circuits and structures are genetically programmed to develop in an organized fashion to produce orderly communication among the brain structures

3. This genetic organization of communication among brain circuits and structures allows normal human functioning and behavior

Prenatal Alcohol Exposure Disrupts and Mangles Brain Circuits. For a brain exposed to prenatal alcohol, however, the genetically programmed migration of neurons is disrupted by the alcohol, which, as discussed in chapter one, is a teratogen. The neurons cannot migrate as intended genetically, so the brain circuits cannot develop normally. The circuits end up deformed or even migrating to the wrong areas, and communication among them is subsequently garbled, open to disruption, and much more difficult to accomplish as compared to a normal brain.

Moreover, some neurons are destroyed or prevented from multiplying by prenatal alcohol exposures, impairing or weakening brain structures and further impairing their ability to communicate. Prenatal alcohol exposures can also prune dendrites and axons, reducing the number of synapses and slowing or destabilizing communications among the brain structures, too. The brain circuits of a person exposed to prenatal alcohol would have brain damage that could be represented in this way (of course, every case can be very different):

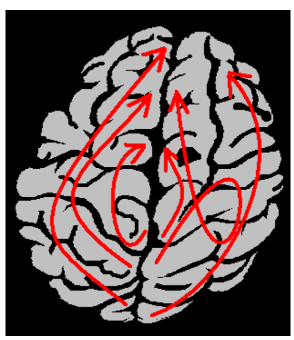

Figure 4: FASD Brain with Garbled Circuits

That is the essence of permanent brain damage for a person with FASD—weakened and garbled brain circuits that cannot communicate or function normally.

Imagine a child with a brain like this exposed to prenatal alcohol. While that brain is an extreme case of prenatal alcohol exposure, brain circuits are still disorganized and communicate inconsistently or inaccurately in the less extreme cases. As noted in Chapter 1, brain damage exists without regard to what the person looks like physically—FASD facial features or growth deficiency can be present or not. But the brain, unseen, is still permanently damaged. There may be no visual cue that the person has a disability—much less permanent brain damage—but their *behaviors* most certainly confirm the disability.

More you need to know:

1. Prenatal alcohol exposure kills neurons, disrupts neuron migration, and prunes dendritic connections, which results in permanently malformed brain circuits and structures
2. Malformed brain circuits and structures cannot communicate and signal each other in a normal, adaptive, predictable way
3. These structural defects in brain formation and brain circuit communication allow lapses and errors in brain functioning
4. This is the essence of permanent brain damage, which results in unpredictable and troublesome functional behaviors

FASD, Brain Functioning and "Problem" Behavior

Why do those with FASD act the way they do? Why won't they just follow directions like anyone else? Why do they sometimes choose to behave but not at other times? Aren't they just being manipulative or taking advantage of the situation? These are common questions asked by caregivers and professionals who work with or care for those with FASD. Let's take a specific example (again, in cartoon format) that can help answer these questions by examining first how a normal brain functions and then how an abnormally functioning FASD brain might behave in the same situation.

Consider the Reticular Activating System, or RAS, situated between the forebrain and hindbrain. The RAS monitors incoming information from the five senses—sounds, the visual field, smells, tastes, and touch (including pain, pressure on the skin, balance, etc.)—and brings abrupt changes and any new or unusual information to the attention of other brain structures. In turn, those structures analyze that information to determine if danger is present and then decide what to do (fight, flight, conscious action, or no action). Abrupt changes and new or unusual things, the "unknown," are assumed to be dangerous until proven harmless, because the brain takes a "better safe than sorry" approach. However, once the brain determines that the information means no danger, the RAS allows a person to habituate to, or ignore, the information—even if it continues to be present in the environment. Otherwise, a person would constantly be distracted by irrelevant noises or other sensations. So, the RAS allows you to first notice, and then tune out, for example, the sound of a jackhammer being used in the street outside your home.

"Normal Brain" Example. Suppose your brain did not experience a prenatal alcohol exposure. Your normally functioning RAS brings the jackhammer's loud, disturbing noise to your attention precisely because it is loud, but also because it is a new and unusual situation (hopefully). Such a noise *could* mean some sort of danger is present, and danger *would* mean you need to act quickly. However, after you look through your window, you see workers repairing your street with a jackhammer, which explains the noise. No danger here, so no survival action is needed, even though you may feel some mild annoyance at being disturbed. After a while though, you tend forget the noise as it fades into the background, and you go on along your

> Normally, the **RAS** monitors incoming sensory signals, bringing them to our attention for potential action. If no action is required, the RAS allows us to ignore that information.

business. The noise didn't get quieter, it's just that your RAS received messages from your higher-level brain centers that there is no danger, so now the RAS relaxes and allows you to tune out the noise. (In fact, you probably won't notice the noise again until it stops, which is when your RAS brings the decrease in volume back to your attention—something new.) This is a normal, automatic process for normal brains.

Impaired FASD Brain Example. A person whose RAS circuits were garbled by FASD will have a very different experience here. Depending on how the RAS is (permanently) damaged, it might never or only sometimes notice a loud noise such as a jackhammer, or perhaps it only notices and reacts to certain types of noise. In this case, the person's lack of awareness could be mistaken for good concentration skills—"My! How she can sit through all that noise and still play her video game, I'll never understand!" Under different circumstances, the person's same lack of awareness could be misinterpreted for inattention or oppositional-defiant behavior—"Michael! I've been calling you for 10 minutes! You never want to listen to me, do you!?" Same underlying problem, but different explanations for the different outward behaviors. And both explanations very wrong.

> An **RAS** damaged by prenatal alcohol exposure may either fail to effectively notice new sensory signals or else be unsuccessful in ignoring those signals. These conditions will create abnormal behaviors.

On the other hand, imagine what it would be like if the RAS were damaged by the prenatal alcohol so that it's unable to habituate properly to the noise. Unable to tune out a jackhammer, a person with FASD might move around the house to find a quieter place. Unable to find quiet, she might continue moving about nonstop and feel frustrated at her inability to find peace. Her outward behaviors would look like hyperactivity; her mood would look sour. What if her RAS could hardly habituate to *any* noise, even simple background noises?—"You just never sit still, do

> Here again, the explanation, or **interpretation**, of a behavior is not really being based on the actual problem (the RAS). We think up our interventions from what we *believe* is causing a problem, but if we're wrong about the cause, then our intervention will not solve the problem.

you? Get hold of yourself! I don't know what we're going to do with you!" Over time, she believes (and knows) the world to be loud, chaotic, and without peace. Eventually, every loud noise could feel like a threat to her peace of mind. Even the quietest noise could trigger a lot of pent-up anger. Soon, she'll get well-meaning (but mostly useless) diagnoses or labels of ADHD (Attention-Deficit/Hyperactivity Disorder), ODD (Oppositional-Defiant Disorder), and/or anger control problems with several recommendations to follow.

The play therapy will be fun, because it's quiet in the treatment room and there's plenty of toys, but "she's just not responding" (because it isn't treating the underlying problem). She'll memorize the anger management techniques (sayings like "Ask yourself 'What is the problem?,' 'Think of your options,' 'Try one out') in the groups or classes, but somehow can't manage to use them when she's angry. The Ritalin or other medication will improve her attention span and hyperactive behaviors to some extent, but most children with FASD end up needing a "cocktail" of medications for optimal results; and an untrained doctor may not realize for several years (if ever). Behaviors worsen, tempers flare, and over time the person with FASD becomes vulnerable to drugs, alcohol, running away, and all the other risk factors discussed in chapter one.

Inconsistent (Impaired) FASD Brain Example. Consider another person with FASD who has "milder" damage of the RAS due to a "mild" prenatal alcohol exposure. In this case, the RAS may work fine under ideal conditions—a nice calm room, no insistence to sit quietly, no stress from arguments with parents or teachers, and so on. This person with FASD may well behave "normally" under certain conditions because they are free of stress. A stressor is anything that might overly excite or stimulate brain circuits, and stressors can originate from either a person's environment (e.g., loud noises) or from inside a person (e.g., a headache, fatigue, bad mood, or any number of other mild to severe internal conditions that bother someone). However, increased stressors could "overload" the RAS in this case, and then the person's brain circuits would become overwhelmed trying to manage all the activated circuits. She would likely exhibit behaviors similar to those in the earlier example.

Under certain ideal conditions, her attention, hyperactivity, compliance and mood will look "normal;" her caregivers and others will tend to believe that she *can* act properly and assume she can do so at all times. They will set their expectations of her to that of a normal person. When she experiences stress, though, she will act out and misbehave because her ability to cope with stressors (via the RAS) is much lower than that of a normal person. Unfortunately, her caregivers and others will not see the stressors, nor will they take them into account to explain her behavior. They will almost certainly hold on to their belief that she is "normal" and expect her to try *harder*, since they have seen her do the right thing before. "She just doesn't *want* to… she's trying to be manipulative."

FASD Brain Damage Multiplies Problems. In these simplified examples, we supposed that prenatal alcohol exposure permanently damaged only one brain structure—the RAS. However, the damage to that one brain structure created several *types* of poorly functioning outward behavior for our not-so-imaginary child with FASD. There are the easy-to-spot problems of her attention skills and hyperactivity (the ADHD) and mental health (anger problems and ODD), and yet there are likely to be other problem areas, too. For instance, if she isn't able to sit still, is oppositional, and has anger problems, then other kids may well avoid her. Under those conditions, she may not learn social skills or how to read nonverbal communications, such as eye rolls or facial expressions or sarcasm (tone of voice).

Of course, prenatal alcohol exposure is not likely to damage only one brain structure. Its pervasive and teratogenic effects cross the placenta and wash over and through the entire developing child. Since the brain develops all throughout pregnancy, any part of it is vulnerable to prenatal alcohol damage at any time. Multiple brain circuits and structures can be damaged, which will create even more complex, interrelated brain functioning problems—as well more complicated and difficult to understand behaviors that require caregivers and others to become exceedingly creative in developing interventions that work. There is never just one simple problem where FASD is involved.

There is no *Mild* Brain Damage from FASD. As you might suspect, even a "mild" case of brain damage from only limited prenatal alcohol exposure can create numerous problems in several areas of behavioral functioning, which, actually, makes it not really mild at all. More severe prenatal alcohol exposures can create even more severe and interrelated problems. Moreover, every case of FASD has a unique pattern of brain damage. This occurs because every pregnant mother who drinks has different drinking patterns, different severities of drinking, different metabolisms, and different levels of health.

These factors interact with the genetic strengths and weaknesses of the developing child exposed to alcohol, too. With such a large number and wide range of variables, it's impossible to predict what type of brain damage will occur, its severity, or exactly how it will be expressed in later behavioral functioning (which then interacts with environmental factors, such as nutrition, stress, and so forth) under various circumstances. This is why expectant mothers are now advised that there is no known "safe" level of alcohol that can be used during pregnancy.

More you need to know:

1. Behavior is related to the brain's ability to function—people with FASD have brain damage and do not function the same way others do
2. Every case of FASD is different, because drinking patterns are never the same for any pregnant mother and every fetus is different

3. There is no known level of "safe" alcohol use during pregnancy

Misattribution—The Key Mistake to Make with FASD

Nobody can know exactly what brain structures are affected or what behaviors will result from FASD. Nobody knows exactly what stressors are currently affecting the brain functioning of someone with FASD. Nobody knows *exactly* why a person with FASD is acting a particular way. And if a person working with someone who has FASD becomes stressed, irritable, or otherwise frustrated by the behaviors, that person is likely to make certain assumptions about the person with FASD. Because of a lack of understanding, the stress involved, and the confusing display of behaviors, caregivers and others tend to assume the FASD behaviors are based on decision and free will. They tend to discount or forget the effects of the brain damage. They try interventions that do not work and then become more frustrated because of these misattributions.

A **misattribution** is believing or assigning the wrong cause to a behavior or event. If a person is sweating, we may assume that the person is too hot. A solution, or intervention, would be to cool the room by turning on the air conditioner—problem solved. But what if the person was sweating because she is ill? Turning on the air conditioner would not address the real cause of the sweating. In fact, it could worsen her illness because she might really need medication to fight an infection. In this case, we have *misattributed* her sweating to a hot room, when, in fact, the real reason is an illness, and the intervention doesn't work the way we intended it to.

Misattribution is believing or assigning the wrong cause to a behavior or event. Just because you *believe* something doesn't mean your belief is true. Most people believe those with FASD are not trying hard enough, but *that belief is not true.*

The same situation—misattribution and incorrect interventions—frequently occurs when working with those affected by FASD. Inadequate or wrong information and/or stress prevents clear and wise thinking about how to solve problems created by FASD. Most people will misattribute inappropriate responses to interventions as a choice that the person with FASD makes consciously. So just as in the above example, if an intervention is used for a person with FASD that does not appropriately take the brain damage into account, then the intervention will probably not work, and everyone involved will feel unsuccessful, leading to more frustration, anger, and blaming.

Four key things to know about misattribution:

1. Just because we *think* we know why a person with FASD is exhibiting a certain behavior doesn't mean our belief is true
2. Just because a person with FASD can *sometimes* act the way we expect her to doesn't mean she is *choosing* to act that way
3. Believing that a person with FASD chooses to act the way she does will create conflict, frustration, failure, and defeatism
4. The basis for interventions is to determine why a behavior occurs and to make an intervention based on that instead of a misattribution

Combating Misattribution. We can only measure and estimate effects of FASD after the fact through observation and assessment of behavior and other aspects of functioning. In the next chapter, the ten domains of functioning will be reviewed. These domains will clearly show where inappropriate behaviors are rooted in terms of brain functioning, which will guide a caregiver or other person toward a more accurate attribution and a more successful intervention.

Next Chapter:

1. Learning the ten domains of behavior that can be affected by FASD to combat the negative outcomes of misattribution.