



OTMASTERY.com

Interoception: A Foundation for Occupational Participation



Introduction	3
Section 1: Basics of Interoception.....	3
Functions of Interoception	5
Types of Interoception.....	6
Interoception Sequence	8
Interoception & Health Conditions.....	10
Section 1 Personal Reflection	12
Section 1 Key Words	12
Section 2: Interoception Assessment & Impact on Daily Life	12
Assessing Interoception.....	13
Categories of Interoception Deficits.....	17
Under-responsive.....	18
Over-responsive	18
Discrimination difficulties	19
Section 2 Personal Reflection	21
Section 2 Key Words	21
Section 3: Intervention for Interoception Deficits	21
Literature on Interoception-Focused Treatment	29
Section 3 Personal Reflection	34
Section 3 Key Words	34
Section 4: Case Study #1	35
Section 5: Case Study #1 Review	37
Section 6: Case Study #2	38
Section 7: Case Study #2 Review	39

Section 8: Case Study #3.....	41
Section 9: Case Study #3 Review	43
References	46



Introduction

Many ADLs and IADLs rely both directly and indirectly on the skill of interoception, making it an essential area of focus for occupational therapists. Interoception supports a person's ability to recognize internal body signals such as hunger, thirst, the need to use the bathroom, pain, fatigue, and general feelings of illness. These internal cues are critical for initiating and completing everyday self-care tasks, maintaining health, and participating fully in daily routines. When individuals have difficulty accurately identifying these sensations, they may struggle with basic activities like eating and drinking regularly, toileting appropriately, or responding to discomfort and pain. Each of these can impact the therapy process as well as someone's well-being. Therefore, it is important that occupational therapists understand how to manage and build awareness of these internal signals as well as develop strategies to respond effectively to such sensations. By addressing interoceptive challenges, OTs can support greater independence, safety, and overall participation in meaningful daily occupations.

Section 1: Basics of Interoception

References: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20

The five basic senses play a major role at the forefront of our everyday lives. Many people are aware of how those senses enable them to participate in various activities. Yet there are other lesser-known senses that are just as important to our functioning, though they tend to be more complex.

One of these is interoception, which is defined as the ability to understand one's internal bodily functions and senses. This skill allows someone to recognize how they feel both physically and emotionally. Interoception was once described more akin to homeostasis in that a person must meet certain physiological thresholds in

order to achieve a 'normal' internal state. However, recent research has led to a greater understanding of the concept. Thus, the more evolved definition of interoception is a dynamic set of nervous system processes that sense and integrate internal stimuli pertaining to each of the body's sensory systems.

Experts find it critical to note that integrating and sensing are bidirectional in nature while also including communication with other vital organs not necessarily given sensory functions. As such, interoception also allows us to feel sensations such as pain and inflammation in parts of the body we may not otherwise be very aware of. Research has also attempted to delve into the figurative line drawn between interoception and exteroception. Many consider the skin to be the boundary between the two. If this was the case, any sensations occurring below the skin would be viewed as interoceptive (and proprioceptive) functions while sensations above or on the skin's top layer fall to a type of exteroception called somatosensation. Even with this description, there is a lot of crossover between the two, which has led professionals to instead view sensory signals based on if they represent the external or internal worlds rather than where they originate.

Regardless of its exact definition, interoception allows individuals to subjectively describe their lived experience. From there, people can attribute meaning to these sensations and categorize them based on their attributes. We rely heavily on interoception to keep our body at an even keel despite various external and internal changes.

Dated research shows that the areas of the brain responsible for interoception are also responsible for functions such as awareness, attention, and the ability to understand subjective experiences. This has led research to focus on some of these topics together, though this may have also prevented more precise analysis of interoception. Even so, some of these studies have told researchers that interoception (and related skills such as mindfulness) assist with neuroplasticity.

This is ideal for therapists and other healthcare providers who address a variety of skills and related bodily functions.

Functions of Interoception

When discussing interoception, it is important to learn the range of bodily functions this skill allows us to recognize. Interoception helps a person be aware of some of the following internal changes:

- Muscle tension or stiffness
- Hunger
- Nausea or other forms of stomach discomfort
- Thirst, which is most clearly seen through a dry mouth
- Pain or discomfort, especially after an injury or illness
- Fatigue
- Flushing or reddening of the face
- Itching or tickling sensations on the skin
- Goosebumps on the skin
- Headaches
- Dizziness
- The need to evacuate one's bowels and bladder
- Detection of any range of stress from mild to major
- Emotions such as anxiety, fear, excitement, embarrassment, and calmness

- Changes in heart rate
- Fluctuations in breathing rate
- A range of temperatures from hot to warm to cold, which is most clearly seen in sweating or shivering
- The connection between your emotional wellness and physical wellness

Types of Interoception

The two main types of interoception are used to describe someone's ability to identify these internal signals. The first is **attention**, which refers to the frequency with which someone becomes aware of their bodily signals. If someone has low interoceptive attention, they may not pick up on small bodily sensations until they become bigger or develop into illness or health conditions. Individuals with high interoceptive attention are overly attuned to their body's internal functioning and tend to dwell on each and every sensation. This may lead them to jump to conclusions about what small sensations mean, thinking that minor health concerns or parts of the human experience are indications of illness, chronic disease, or even signs of imminent death. High interoceptive attention may also lead someone to excessively focus on one aspect of their internal signals. For example, they may be convinced that a minor stomachache means food poisoning or a virus instead of being connected to emotions such as anxiety. There are several obvious concerns related to this type of misinterpretation. Namely, this tendency can lead someone to experience more discomfort as a result of ignoring the emotional side of certain bodily signals, creating a feedback cycle that can be difficult to break.

The second form of interoception is **accuracy**, which focuses more on the precision of someone's ability to identify their own bodily signals. Interoceptive

accuracy (also known as interoceptive sensitivity) means that someone can correctly and objectively pinpoint the cause of a racing heartbeat, for instance. But this type of interoception also allows someone to notice their bodily signals with relative ease. People with excellent interoceptive accuracy may be able to sense their own heartbeat by simply quieting down and listening. Others may need to rely on tactile input to determine their heart's functioning by placing their finger on their wrist or over their heart and counting out beats. Individuals who demonstrate high interoceptive accuracy may also be able to tell the difference between stomach discomfort due to hunger, illness, or emotions.

The Multidimensional Assessment of Interoceptive Awareness (MAIA-2) Scale is a standardized assessment that can be used to gauge a person's interoception skills. We will discuss this outcome measure along with others in a later section. However, it outlines eight specific components of interoceptive accuracy that therapists should be aware of. These include noticing, attention regulation, emotional awareness, trust, body listening, not worrying, not distracting, and self-regulation. Each of these dimensions is useful in helping therapists determine the ways in which a person perceives and reacts to internal sensations.

Just because someone has strong skills in both types of interoception, this doesn't mean they necessarily are in tune with those signals. For example, someone may possess the ability to sense their heart beating without actually feeling for a pulse. Even if someone has had this skill for as long as they can remember, they may not use it often. It's possible people like that have become used to such bodily sensations and don't pay attention to them (or act on them) the way they once did.

Interoception is similar to other forms of sensory input in that people can have different abilities to process this sense. Just like someone can be over-responsive to auditory input and normally process other forms of sensory stimuli, the same

goes for the interoception types. Someone can have high interoceptive accuracy along with low interoceptive attention and vice versa. It's also possible for a person to have concerns related to one type of interoception, but possess normal functioning of the other form of interoception. Interoception presentations can vary greatly from person to person.

Interoception Sequence

When someone possesses the skill of interoception, their body follows a series of steps to alert them to a certain sensation or bodily function. The first step begins when neurons designed to sense bodily functions (interoceptors) are **triggered**. This sends an electrical signal to various other neurons that eventually lead to the brain. Depending on what type of sensation the body has picked up on, that information will travel to specific areas of the brain. These may include:

- **Brain stem:** The brain stem primarily controls involuntary bodily functions. If interoceptors send information here, it may be regarding someone's level of alertness (assisting with sleep and wake cycles), heart rate, breathing rate, and blood pressure. The brain stem also manages some movement (specifically swallowing, facial movements, and blinking), sensation in the face, taste, balance, and hearing.
- **Hypothalamus:** This brain region plays a large part in helping the body maintain homeostasis and also affects hormones due to its connection to the endocrine system. Interoceptors may send information about thirst, hunger, appetite (whether we are full or not), libido, body temperature, and mood to the hypothalamus.

- **Thalamus:** When interoceptors send information to the thalamus, it typically is regarding pain, mood, motivation, alertness, attention, emotion regulation, and sensory information (minus stimuli pertaining to smell).
- **Anterior cingulate cortex:** Because of the functions of the anterior cingulate cortex (or the ACC), interoceptors traditionally send information here that pertains to motivation, attention, and mood.

Once the information gets to the corresponding section of the brain, it is then **interpreted**. The brain translates the information into words someone can understand. For example, signals will turn into phrases such as 'I am tired,' 'My back muscles are tense,' and 'I have butterflies in my stomach.'

From there, we **attribute emotion and meaning** to these phrases. By attaching meaning to objective information, we not only gain a better understanding of what certain bodily signals mean but we also turn that data into a subjective, lived experience. This stage of interoception takes place in the insular cortex (also known as the insula). This part of the brain gives phrases more complexity. For instance, 'My back muscles are tense' may turn into 'The nervousness I am feeling is making the muscles around my back tense.' Depending on someone's skill in this area, these phrases may even expand upon why you feel a certain way. For instance, some people who are especially aware of their feelings and their body may recognize that the anxiety they are feeling is from a tight deadline they are up against at work, which is leading to their muscular tension.

Lastly, a person combines all of this information to **make a decision about their subsequent behavior**. The mind as a whole works to determine whether the sensation is harmless or threatening. The brain may also come to the conclusion that the sensation doesn't yet fall into either category. Regardless, the brain's decision about this information will inform a person's next steps. Will the person:

(1) act on the sensation, (2) wait until they have more information to make a decision, or (3) ignore what they feel?

There are countless possibilities in this last stage, as interoception is affected by various internal and external factors. Perception from one's peers or superiors is one example. Someone may want to avoid being seen as lazy, leading them to ignore signs of illness and push through the remainder of their work day. If the sensation they choose to ignore occurs during a social outing, they may want to avoid being seen as unfriendly. Environment is an external factor that can impact someone's health responses. Let's say someone is experiencing muscle tension and pain while traveling on a bus or an airplane. The person may want to adjust their posture to get more comfortable, but these locations will likely prevent them from doing so. Due in part to their inability to act on those pain sensations, the person may experience even more discomfort as time goes on. If they continue to ignore these signals, it's possible they will develop a musculoskeletal injury or worsen an underlying condition.

Interoception & Health Conditions

Health impairments are another example of an internal factor that impacts one's interoceptive abilities. In particular, therapists should understand how the skill of interoception is associated with alexithymia. While alexithymia doesn't necessarily impact all of the bodily functions involved in interoception, there is definite crossover between this skill and symptom. Alexithymia causes someone to have difficulty recognizing and expressing their emotions. This leads to limitations in emotional awareness, which is seen in a range of neurological and psychiatric conditions that have the potential to cause poor interoception.

Etiology is another similarity between alexithymia and impaired interoception, as individuals can experience either of these concerns as a result of trauma, genetic variations, and abnormal brain development.

Several medical conditions have been linked to impaired interoception. Dated research has estimated the prevalence of alexithymia within these diagnoses, which is quite substantial for many of the conditions listed:

- Anxiety disorders (estimated prevalence of 13% to 58%)
- Attention-deficit/hyperactivity disorder
- Autism spectrum disorder (estimated prevalence of 40% to 60%)
- Chronic pain disorders such as fibromyalgia
- Depersonalization-derealization disorder
- Depressive disorders (estimated prevalence of 32% to 51%)
- Digestive disorders
- Eating disorders (estimated prevalence of 24% to 77%)
- Learning disabilities
- Neurological conditions such as multiple sclerosis, Parkinson's disease, dementia, and traumatic brain injury
- Obsessive-compulsive disorder (estimated prevalence of 11% to 36%)
- Panic disorder
- Post-traumatic stress disorder
- Somatic symptom disorder

- Spinal cord injury
- Substance use disorders (estimated prevalence of 30% to 50%)

Section 1 Personal Reflection

What aspects of the interoception sequence are occupational therapists trained to address as part of their scope of practice?

Section 1 Key Words

Exteroception - The ability to sense stimuli from the external world; the five most predominant and well-known senses (taste, touch, smell, sight, and hearing) are responsible for taking in and, partly, processing information associated with exteroception

Homeostasis - The constant flow of feedback loops that create an equilibrium between various bodily functions and allow stability within the body; homeostasis involves keeping a balance between functions such as waste excretion, blood pressure, body temperature, pH balance, blood glucose levels, concentration of ions and water within bodily fluids, and more

Section 2: Interoception Assessment & Impact on Daily Life

References: 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38

Therapists must recognize the signs that someone has impaired interoception in order to properly address this skill. It's common for children and adults with interoception deficits to feel anxious or stressed easily due to impaired emotion

regulation. Clinically, this may present as poor frustration tolerance and low resilience to stress and challenges. These concerns can negatively affect a range of areas including socialization, school or work performance, and functioning in IADLs and ADLs.

Poor interoception can also cause a high or low tolerance for pain and discomfort. This can lead to accidents and injuries. In more severe cases, individuals can experience medical complications (such as infections) resulting from non-treatment and even unintentionally exacerbate chronic conditions.

Individuals with impaired interoception may have difficulty knowing their bladder or bowels are full. Therefore, children may demonstrate delays in potty training completion and people of any age may experience frequent accidents throughout the day.

Since interoception deficits can prevent someone from recognizing they are full after a meal, people with this concern may overeat. This places a person at risk of obesity and related health concerns. On the other end of the curve, interoception delays can cause someone to not feel hungry or thirsty, which may lead to malnutrition.

Lastly, trouble regulating body temperature can lead people to experience further discomfort during winter and summer months. This can become even more hazardous in extreme temperatures, as someone is at risk of hypothermia or heat exhaustion. If not addressed or managed, these medical emergencies can lead to organ failure, seizures, and long-term neurological damage.

Assessing Interoception

Since interoception deficits can have such a large impact on a person's life in terms of occupational engagement and independence, it is important for

occupational therapists to identify these concerns in their patients. This starts with thorough screening and assessment followed by intervention to prevent or lessen potential negative effects.

There are various tools therapists can use to assess and monitor interoception. These include:

- [Body Awareness Questionnaire](#)

An 18-item self-report tool that involves rating items on a 1-7 Likert scale.

- [Body Perception Questionnaire](#) (BPQ)

This self-report assessment focuses on a range of autonomic nervous system functions. Once a therapist calculates a patient's combined scores, they can determine a person's autonomic stress response patterns. The BPQ has two subtests: one for autonomic reactivity and another for body awareness. The latter of these two is especially helpful in weighing a person's interoception skills.

- [Comprehensive Assessment of Interoceptive Awareness](#) (CAIA), 3rd Edition

This tool includes picture cards to assist with emotion regulation and identification, a caregiver questionnaire, and a self-report interview. With this variety of assessment components, CAIA accommodates individuals with a range of learning and communication styles. This assessment can be used with children and adults with a wide variety of diagnoses.

- [Interoception Evaluation and Support Plan](#)

Rather than some other tools that guide therapists in assessing interoception, the Interoception Evaluation and Support Plan offers a template for therapists to track their patients' interoception skills over time

and devise a plan to address certain skills that are lacking. The tool's authors report this can be used with children and adults.

- Interoception Sensory Questionnaire (ISQ)

A 20-item checklist to be used with adults who have autism spectrum disorder along with interoceptive confusion. The only exclusionary criteria for the ISQ is having extreme interoception deficits, called alexisomia.

- [The Multidimensional Assessment of Interoceptive Awareness](#) (MAIA)

This 32-question self-report tool has eight subtests: not worrying, not distracting, noticing, attention regulation, self-regulation, body listening, emotional awareness, and trusting. The MAIA assesses various aspects of interoception including emotions, which is not a fixture in all interoception measures.

- Sensory Profile: Interoception Scale (SPI)

The Sensory Profile is a well-known outcome measure focused on testing various types of sensory regulation. Recently, the authors developed an interoception scale to complement their existing assessment. This scale is designed to measure interoception in adults and is considered the first participation-based look into this skill. As with other portions of the Sensory Profile, the SPI contains avoiding, sensitivity, registration, and seeking subtests to offer providers a deeper look into how a person's nervous system responds to certain sensations on a regular basis.

There are additional measures of a person's interoception. Depending on their access to resources and training, OTs may or may not be able to use these assessments. However, they are still worth mentioning, as therapists may come across data related to these tests in the process of addressing interoception:

- **Heartbeat-Evoked Potentials:** The HEP is an objective measurement of transient electroencephalogram (EEG) signals in tune with heartbeats via electrocardiogram (ECG). Objective results from this test represent the way a person's brain processes interoception related to the heart. HEP data can be used to indicate someone's emotion, attention, and respiration. This is one of the most common objective tests to measure interoception during infancy. Greater HEP amplitude results from heart sensations, exhalation, and emotional states/high arousal.
- **Heart Tracking Tasks:** This is a more subjective way of determining a person's perception of their heartbeat. There are several variations of heart tracking tasks, though the most common has someone tally the number of beats across various time intervals (15, 30, 45, and 60 seconds). From there, providers determine accuracy by comparing these numbers to their own accounts of the person's heartbeat. Results are produced by subtracting reported heartbeats from actual heartbeats and dividing that figure by the actual number of heartbeats. These tasks can be given with or without adaptations, and they are best suited for children. A person is considered to have strong interoceptive awareness when there is a strong correlation between the actual accuracy of heartbeats and a person's confidence in their perception of their heartbeats.

Therapists must weigh the results from objective measures carefully against those from subjective measures. As with other types of assessment data, subjective test results should be used in conjunction with functional, objective, and occupation-based tools. Since subjective measures are difficult to quantify, therapists can experience difficulty creating goals and tracking progress with them over time. This emphasizes the importance of variety in the evaluation process.

In addition, therapists should use caregiver report-style assessments with caution during the evaluation process for interoception skills. This is mostly due to concern over whether or not another person can accurately determine another person's perception of themselves. As with other subjective-leaning assessments, they can provide some insight into a person's behaviors, routines, and habits. However, it is especially important to interpret results from such outcome measures with these considerations in mind.

Categories of Interoception Deficits

As with other sensory concerns, someone can be over-responsive to interoceptive input, under-responsive to interoceptive input, or have discrimination difficulties when it comes to identifying the body signals associated with interoception. Someone can fall into more than one category depending on the type of interoceptive input their sensory systems are processing, and people can also move between these categories across their life. Research shows that children with interoceptive difficulties more often tend to be over-responsive while adults with interoception deficits are more likely to demonstrate under-responsive behaviors.

Just as older adults experience a decline in vision, hearing, and tactile function as they age, interoceptive abilities also decline during this phase of life. These age-related nervous system changes have the biggest impact on interoceptive accuracy, or someone's ability to objectively sense certain bodily signals. Studies show that age has a different effect on subjective awareness, which stands to influence an older adult's perception of other interoception aspects (e.g. emotion regulation). This may also contribute to someone's increased risk of mental health concerns in later stages of life.

Under-responsive

Someone with this type of interoception deficit will have difficulty recognizing signals from their body. This may lead them to:

- Rarely feel thirsty
- Rarely feel hungry (An inability to recognize hunger signals can lead someone to experience frequent drops in blood glucose levels and surges in hormone levels due to decreased appetite. In the long-term this may result in malnutrition, disordered eating habits, or diagnosed eating disorders.)
- Experience dulled pain signals (This may manifest as ongoing feelings of malaise without a known cause, unintentional self-injurious tendencies, and a delayed ability to seek medical attention. Dulled pain signals can also cause small injuries to turn into big ones due to the development of infections and other medical complications.)
- Have trouble identifying or sensing emotions in the early stages (This can cause a fear of strong emotional responses, frequent outbursts or meltdowns, and poorer overall mental well-being. Each of these outcomes can place someone at a greater risk of mental health diagnoses.)
- Struggle with knowing when to use the bathroom (placing them at risk of urinary tract infections and chronic constipation. Children with under-responsive interoceptive abilities may have difficulty with potty training, either experiencing delays in the process or having partial potty training skills.)

Over-responsive

By being over-responsive to interoceptive input, someone will experience difficulty ignoring their bodily signals. This may lead them to:

- Feel unable to quench their thirst (This can cause excess consumption of fluids, leading to electrolyte imbalances, chronic migraines, and seizures.)
- Continually pick up on hunger signals (This can lead to surges in blood glucose levels and hormone imbalances. People may also develop overeating habits and possibly also eating disorders in the long term.)
- Feel overly strong pain signals (This can cause someone to seek medical attention for even minor concerns and require extended recovery time after injuries or illnesses. In children, they may be labeled as having attention-seeking behaviors while adults might be diagnosed with hypochondriasis.)
- Experience emotions more intensely than others (People who demonstrate this concern may more drastically and more frequently shift between emotions that others experience more smoothly or less often.)
- Have the urge to urinate often (This can lead to frequent bathroom use, which may impact productivity in work or school settings. Such a habit may also lead to nocturia, meaning they can experience sleep disruptions. Frequent urination may also impair attention, especially during seated tasks, or the ability to travel long distances in a car or other form of transportation.)

Discrimination difficulties

This type of interoception difficulty can prevent someone from determining what certain bodily signals are. They may be able to vaguely sense the need to do something or feeling something, but be unable to identify exactly what it is. As a result, discrimination difficulties can cause trouble managing sensations due to not properly recognizing them. This may lead someone to:

- Have difficulty determining the difference between similar signals (e.g. being thirsty or having a sore throat; needing water/food or experiencing anxiety)
- Have difficulty telling what they need to quell a certain sensation or react to a certain signal (Some examples of this in daily life include scratching excessively instead of washing one's hands to remove dirt/debris or taking medicine to relieve a scratchy throat that may have resolved from taking a sip of water. There are a range of other instances, all stemming from someone doing too much or engaging in unhelpful behavior to try and alleviate their discomfort.)
- Experiencing ongoing feelings of being unwell, but being unable to verbalize what is wrong or even express what body part is having an issue (Similar to someone who has overly strong pain signals, this may cause a person to seek medical attention often with little to no results.)
- Be confused between emotions (This can lead someone to have difficulty identifying and communicating their emotions.)
- Have difficulty meeting their bodily needs (This can cause someone to struggle with basic and complex aspects of their health, including but not limited to managing minor illnesses or health problems. Adverse effects and complications range depending on the function. For example, not using the bathroom regularly can lead someone to get urinary tract infections, become chronically constipated, or experience bowel obstructions. They may also not be able to find clothes that they find comfortable, leading to excessive fidgeting or difficulty getting dressed in a timely manner each day.)

Section 2 Personal Reflection

What signs and symptoms that point toward under-responsive interoception abilities may mimic that of other sensory deficits?

Section 2 Key Words

Electrocardiogram - A method of measuring heart function that involves tracking its electrical activity through electrodes placed on various parts of the surface of the chest

Electroencephalogram - A method of measuring brain function that involves tracking its electrical activity through electrodes placed on various parts of the surface of the head

Malaise - Non-specific illness or discomfort; many people have difficulty describing malaise, but may use terms such as being 'out of it,' having low energy, or not feeling like themselves

Section 3: Intervention for Interoception Deficits

References: 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57

The occupational therapy interventions that therapists use to address interoception skills vary based on a person's exact concerns. For example, someone with more global sensory deficits across all areas may participate in a range of gross and fine motor activities to address each sensory skill. A person with more targeted interoception concerns may benefit from some gross motor skills along with more discussion-based interventions to target areas such as emotion regulation, mindfulness, and awareness. As with many interventions, a

person's age, diagnosis, cognitive functioning, and several other factors also play a part in which interventions are the most beneficial.

Therapists can use some of the following interventions to build a person's interoception skills:

- The provision of and training on external supports to help monitor bodily signals
 - Smart watches can be used to measure heart rates, respirations, and other vital signs
 - Weather apps can be used to improve awareness to temperature
 - Smart water bottles with linked apps or standalone apps can both be used to remind someone to drink water throughout the day
 - Hard copy visual schedules, phone or computer alarms, or posted reminders can be used to remind someone to drink, eat, and/or use the bathroom at regular intervals (or check in with themselves to see if they need to do any of these activities)
 - Bristol stool charts and urine color charts can be used to check someone's fecal matter and other output to monitor their health
- The provision of equipment, tools, and strategies that can assist with managing bodily signals and maintaining self-regulation is another complementary intervention for interoception. Therapists should aim to incorporate gross motor activities that provide heavy work, calming and regulating input, and rhythmic movements to assist with balancing the nervous system.
 - Calming and regulating activities help balance emotions and related bodily functions.

- Reach and breathe
 - Starfish breaths
 - Bend and stretch breathing
 - Yoga poses such as downward dog, warrior pose, child's pose, corpse pose, forward fold, pigeon, cat-cow, camel, and drop swings can all improve breathing and aid in emotion regulation
 - Watch the target: instruct the patient to move slowly to follow a target they are controlling while taking deep breaths in and out; time it so that upward motions correspond with in breaths and downward motions correspond with out breaths
 - Heartbeat check-in: sit in a quiet place with a hand on the chest or wrist, engage in light movement such as stretching, then assume the initial position and recheck heart rate
 - Breath awareness: slowly breathe in and out, place one hand in front of your mouth to check the breath temperature, then alternate between fast and slow breathing while paying attention to how the temperature of the air changes
- Heavy work activities help build body awareness, which assists with both proprioception and interoception skills. Since the two are closely related, therapists should aim to address both in tandem. There are various categories of heavy work activities that can benefit individuals needing interoception skills.
- Chewing: OTs may make recommendations including snacking on sticky, crunchy, or chewy snacks to stimulate oral motor musculature and awareness, chewing on gum or eating mints

throughout the day, using necklaces and other body jewelry designed for chewing or sucking, and using a straw or sports water bottle to drink. Therapists can also engage patients in various therapeutic activities involving a straw such as blowing a tissue across a table using a straw, using a straw to suck and pick up small pieces of paper or tissue to transfer from one spot to another

- Pulling: Tug of war, use of a pull-up bar to do full-body pull-ups or chin-ups, rowing, kettlebell swings, and theraband exercises and stretches can all be used as therapeutic exercises or to create a home program.
- Lifting: Some of the most obvious exercises in this category include the use of dumbbells and similar weighted equipment. However, other activities that involve lifting and can be used with younger populations include doing repetitions of lifting with weighted stuffed animal exercises, full tote bags (of laundry or groceries), or weighted backpacks. Other options are leg lifts, bridge exercises with the addition of a hold.
- Carrying: Nearly all of the lifting exercises can be applied to this category by incorporating them into functional tasks or therapeutic activities rather than focusing on repetitions. Other ways to address carrying include holding some of the above items while navigating through an obstacle course, which can be especially fun for children.
- Jumping: Activities in this category include couch, mattress, or trampoline jumps, rocket jumps, star jumps, jumping jacks, bouncing on a hopper ball, burpees, jumping squats, box

jumps, jumping rope, and jumping lunges. Many of these naturally appeal to children and can be incorporated into obstacle courses or even done in interval training format.

- Pushing: Again, many pushing exercises can draw from those that target pulling, lifting, and carrying. These can include wall push-ups, chair push-ups, knee push-ups, pushing a full laundry basket/box/wheelbarrow/grocery tote/wagon/sled, moving a therapy ball up the wall with only your hands or only your feet, and pushing a person on a swing.
- Squeezing: These can include exercises or activities with tennis balls, exercise balls, stress balls, play-doh, or theraputty. OTs can carry out a range of squeezing activities with sponges, spray bottles, clothespins. Other examples include pillow squeezes and bear hugs. Household tasks such as cooking and laundry (e.g. wringing out wet clothes) also offer many opportunities for squeezing.
- Climbing: Jungle gyms and traditional playground equipment allow children to free climb in various ways. Therapists can also incorporate games such as the floor is lava and shark attack into the use of this equipment.
- Pinching: Many of the squeezing activities can be modified to address grasp and pinching skills. In addition, therapists can encourage children to use tongs, tweezers, and fingers to grasp and release small objects during activities. Objects may include googly eyes, small pom-poms, beads, small pieces of uncooked pasta or rice, stickers, buttons, and more. These also offer many opportunities for functional tasks.

- Daily journaling can help someone identify and track their emotions over time. Depending on the person, it may help to start with specific journal prompts that help with emotion recognition and then decrease prompts over time as someone builds skills.
- Creative arts, including writing, reading, drawing, painting, sculpting, photography, music, theater, dance, and more, can all be used to help someone build awareness of their emotions
- Mindfulness practices such as progressive muscle relaxation (PMR) and guided imagery can be used to improve body awareness and someone's ability to ground themselves. The core skill involved in many mindfulness activities is performing a body scan.
 - Therapists can teach body scans by having patients assume a comfortable position, either sitting or lying down. They should close their eyes and guide patients in taking several deep breaths (in through their nose and out through their mouth). During this time, therapists can guide patients in recognizing how their body feels in their chosen position. Once they are comfortable in that and have completed a certain amount of breaths, therapists can instruct patients to focus on one section of their body at a time starting at the top of their head. They can move from their head down to their face, neck, shoulders, arms, hands, chest, abdomen, back, hips, thighs, knees, calves, and feet. They should spend at least 30 seconds focusing on each part of their body, including discomfort or pain but also more basic sensations like how their clothes feel on that part of the body, muscle tension, and the way it sits at rest.
- Deep breathing exercises such as box breathing and diaphragmatic (belly) breathing can be helpful. This strategy can also be combined with

mindfulness such as in lazy 8 breathing exercises, which involves visually tracing one loop of an imaginary infinity symbol as they breathe in and the other loop as they breathe out.

- Walking patients through Cognitive Behavioral Therapy (CBT) to increase awareness of one's body and modify negative thoughts patterns, beliefs, or feelings that may be present surrounding self-care and responding to one's own needs.
- Body signal bingo and similar games can be used to teach patients about various body parts. These can also be used to create visual charts and other references for patients to use as reminders.
- The creation of routines can be helpful for building interoception, especially with babies and young children. Therapists can assist in structuring a person's day to allow time for rest and reflection. In addition, a sense of predictability can help regulate the nervous system, allowing for a greater sense of awareness.
- Educating young children about the words or gestures to describe various bodily signals is another important part of interoception. In order to be maximally effective, education should also address the various ways interoception impacts function and daily life. OTs can collaborate with SLPs and behavior therapists to create and/or customize augmentative and alternative communication devices (AACs) that cover an appropriate range of bodily signals. Therapists from any discipline can reinforce the use of these strategies across all contexts.

Therapists can use several approaches in the process of addressing interoception. Social learning theory can assist in modeling certain behaviors and language. For example, therapists can speak in a way that encourages critical thinking about

one's bodily functions. Therapists can use prompts such as, "What is your body telling you right now by giving you a headache?" or "Does your body feel anxious right now?" These can be used as a springboard for many interoception interventions. Modeling is another aspect of social learning theory that can assist with learning interoception skills. Therapists can use their own lives and daily experiences to teach patients about interoception. Similarly, therapists can use such approaches to explain activities as they walk patients through them. If a patient is using instruments to perform manual-assisted soft tissue massage on a patient, they may state, "The cold from this metal handle feels like my skin is stinging" and can even pair it with one of the questions above to encourage the patient to elaborate on their own experience with the tool. A therapist playing balloon volleyball with a child may say, "Running back and forth to bat the balloon before it hits the floor is making my heart race. What are you noticing about your heart [or other body part] right now?"

Another way therapists can incorporate this approach into sessions is by going through an entire sequence. For instance, a therapist may start by demonstrating a body scan to their patient then verbalize what they noticed followed by how the interpretation of those signals made them feel. Lastly, the therapist should round out the demonstration by detailing the action steps they will take to address those signals. Therapists can model this type of behavior by making space at various points during a session to engage in such discussion or verbally express such signals. It can be helpful to offer time before, during, and after activities, or even more organically.

Patients who have difficulty with the expression part of the activity may benefit from therapists teaching them a structure. Something such as "My [body part] does [sensation] when I feel [mental state, emotions, etc.]." They can be encouraged to take pauses throughout the course of a regular day to complete a

30 to 60 second body scan and use the above verbiage to express the results of that scan.

If a patient demonstrates the ability to verbalize a bodily sensation (either with help or alone), therapists can take the skill one step further and offer choices that may assist with managing the signal. Some choices may include selecting a preferred activity to get energy out or destress, having a toilet break, stretching, getting a drink, eating a snack, or pausing to rest. These are just a few of the most common strategies, but these can be expanded quite a bit depending on a person's interests and resources.

Some approaches are specific to interoception and related skills. Mindful Awareness in Body-Oriented Therapy (MABT) helps therapists and other providers teach the skills most fundamental to interoception. MABT does this through a combination of psychoeducation, mindfulness, and manual techniques. Research shows that MABT can improve emotional and physical sensory-related awareness, ease overall distress, and enhance self-regulation skills. Mindful Awareness in Body-Oriented Therapy is intended to individualize the way interoception is taught using psychoeducation along with somatic approaches and scaffolding techniques. This pairs well with components of behavior modification and CBT.

Literature on Interoception-Focused Treatment

Research has looked into various aspects of assessment and intervention focused on interoception as well as other skills interoception may impact. Some studies cover intervention provided by OT and some research studies treatment administered by disciplines such as psychologists, mental health counselors, and more. Therapists can use each piece of research to inform their planning and treatment when addressing such a skill in practice.

Interoception has been closely related to other sensory functions as well as executive functions such as attention. Poerio et al. (2024) found that a person's interoceptive signals were an accurate reflection of their attention around 20% of the time and an accurate reflection of their auditory functioning around 83% of the time. This study also showed that higher levels of attention were closely associated with negative emotions and fatigue. This points toward a distinct difference between interoceptive attention and exteroceptive attention. While the two are associated in some ways, therapists must keep these differences in mind when creating interventions that address one or both areas to ensure all of their patients' needs are met.

Research from Tan et al. (2023) similarly looked into the link between interoception and emotions. They found that, by improving interoceptive attention, individuals may also experience an increase in emotional awareness. Therapists can use this connection to inform their treatment by pairing therapeutic activities aimed at multisensory integration with various emotion regulation strategies. This also allows patients to work on flexibility in using certain techniques in the most appropriate situations and across various contexts.

Mulder et al. (2024) conducted a systematic review to explore some lesser-discussed activities in terms of their relationship to interoception. These researchers found that, in general, interoception was positively associated with certain eating habits (namely, fasting), cognitively-stimulating leisure tasks, and relaxation-inducing activities. Increased interoception scores were linked to an increased frequency of sleep disturbances, as someone who astutely recognizes bodily signals may even sense them during the night. Alcohol consumption was found to decrease a person's interoception skills due to the substance acting as a central nervous system depressant. There were inconsistent results regarding the relationship between interoception, smoking, and exercise. While exercise is usually considered a therapeutically beneficial activity, this research suggests

therapists should weigh the impact of various types of exercise as well as how they influence certain people. For instance, people who dislike running or have physical concerns (such as joint problems) that make such an activity difficult may tend to connect less with running. In turn, this may also cause them to experience negative effects in terms of interoception as a result of engaging in running, such as increased frequency of joint pain along with heightened sensitivity to that pain. As a result, it may benefit patients to supplement exercise with activities that have a strong cognitive component and those that are considered personally relaxing. Since many OT interventions address both cognitive and physical client factors at once, this is yet another area where our discipline can benefit patients.

Price et al. (2024) explored the benefits of the MABT approach when used with individuals who have opioid use disorder. Results of this study showed MABT significantly improved pain severity, pain activity interference, frequency of physical symptoms, interoceptive awareness, and PTSD symptoms when compared to people who received medication only. This can be used to inform the practice of therapists working in mental health fields. Since there is a growing movement toward more holistic alternatives to pharmacological treatment, this may become a more commonly used approach for patients who have substance use disorder.

Another study explored the effects of certain interoception skills on diagnosed mental health conditions. Sun et al. (2024) looked into the link between interoceptive sensitivity, physical activity, and clinical depression. Results showed there was a significant negative correlation between physical activity and depression along with a significant positive correlation between seven dimensions of interoceptive sensitivity and physical activity. This confirms what we have known for some time: that exercise and movement can be helpful for managing depression and that movement-based activities can help improve interoception. Researchers were also able to find a negative correlation between interoceptive

sensitivity and depression, which can assist providers in better managing this and similar mental health concerns. This study went on to find that the 'not distracting' and 'trusting' components of interoceptive sensitivity had an indirect (but significant) influence on the link between physical activity and depression. Such results suggest that physical activity might reduce depressive symptoms by means of improving these two aspects of interoceptive sensitivity. As such, therapists should make every attempt to integrate interoceptive sensitivity into treatment for patients with depressive symptoms. This can be done by adding mindfulness and gross motor components to treatment plans for those with mental health concerns. This data also justifies therapists making some exercise recommendations for patients to further increase their activity levels outside of sessions.

Santamaria-Garcia et al. (2025) studied the concept of allostasis and its relationship with interoception (specifically interoceptive overload). These researchers found that impairments in allostatic interoceptive processing may be present in various types of dementia, anxiety disorders, clinical depression, and several other neuropsychiatric conditions. These researchers also discussed whole body cascades and epigenetic pathways, suggesting the impact that environmental factors may play in the development of such concerns. These researchers also mention that interoceptive overload can negatively affect inflammatory and immune processes along with communication between the brain and other organs such as the heart, lungs, and gut. This study recommends the creation of treatment frameworks that take a trans-nosological and dimensional approach to adequately address interoceptive overload. OT already aligns well with such frameworks due to its focus on underlying mechanisms contributing to functional deficits. However, the development of such an approach would still be highly useful in the standardized and comprehensive treatment of this specific interoceptive deficit.

Pasciuccio et al. (2026) looked at how interoception and multisensory integration predict physical functioning in older adults as well as younger adults. Older adults demonstrated a link between interoceptive awareness, interoceptive sensibility, multisensory temporal resolution, and physical functioning. Specifically, individuals who possessed the first three skills tended to have better physical functioning than those who did not have such skills. Higher interoceptive sensibility and awareness were associated with better physical functioning, while reduced temporal resolution was linked to poorer functioning. These factors also predicted role limitations due to physical health: higher interoceptive awareness and sensibility were related to fewer limitations, whereas temporal resolution and tactile acuity were associated with greater limitations. The results of this study suggest the importance of treatment addressing interoception as well as other forms of sensory functioning across the lifespan. This type of intervention can be especially beneficial in improving safety, decreasing falls, and maintaining functioning in older adults at risk of chronic conditions.

Occupational therapists Mahler et al. (2022) conducted a study on the efficacy of a 25-week school-based intervention that focused on emotion regulation and interoception in kids with autism spectrum disorder between 9 and 19 years of age. While the sample size was relatively small, the intervention yielded statistically significant improvements in both skills. This not only demonstrates the benefits of OT intervention for both interoception and emotion regulation skills, but also confirms the feasibility of providing this intervention within a school setting.

Another study explored interoception and related concerns in those with autism, though these researchers targeted adults. Bonete et al. (2023) looked into interoceptive confusion, emotion regulation skills, and alexithymia in people with autism spectrum disorder. Individuals with autism were found to have impaired interoception, alexithymia, and emotion dysregulation, though each factor was

significantly different in all study members (those with and without autism). There was a major correlation between interoceptive confusion, alexithymia, and emotional clarity in those with autism. But the only connections in those without autism were between interoceptive confusion and alexithymia. In terms of carryover to OT practice, this study indicates that treatment addressing interoception may lessen the negative impact of alexithymia and increase emotional clarity in individuals with autism.

OT researchers Pereira-Hudson et al. (2024) found that many occupational therapists failed to regularly evaluate and address interoceptive awareness in clinical treatment with adults. However, OTs did report a high level of efficacy (63%) from this type of treatment when they did provide it.

Foster et al. (2025) looked at the benefits of a responsive feeding program focused on building interoception skills, caregiver training, and 6 months of coaching when provided to children who were tube-fed at least part of the time. Results showed that all participants reduced tube use following the program and demonstrated continued improvement as a result of the follow-up coaching. Caregiver competence also improved, though caregiver stress stayed the same.

Section 3 Personal Reflection

What settings might an occupational therapist be able to provide interoception intervention in? Are there any settings where this type of treatment would be inappropriate or ineffective? If so, why?

Section 3 Key Words

Allostasis - The process of responding to the body's biological processes through both adaptive and proactive regulation

Interoceptive overload - A neurological state of hypersensitivity that results from numerous and/or high intensity internal signals or the perceived inability to ignore bodily signals; this type of overload mimics that of defensiveness and oversensitivity to other types of sensory input and can create outward reactions such as difficulty concentrating, emotional distress, aggression, irritability, anxiety, and difficulty functionally participating

Interoceptive sensibility - The ability to objectively sense one's bodily signals and use that information to guide critical thinking, decision-making, and emotional stability; this is a slightly more refined version of interoceptive accuracy, as it involves properly synthesizing information from their sensory systems

Multisensory temporal resolution - The brain's capacity for discerning between various types of sensory input that occur at different points in time; this skill allows someone to string together a series of events to more accurately perceive their surroundings

Pain activity interference - The degree to which someone's pain impacts their participation in various occupations, including socialization, work, school, personal care, and recreation

Transnosological - A frame of reference within psychiatry and some other medical specialties that involves root cause identification (including but not limited to the analysis of biomarkers, shared clinical symptoms, and underlying mechanisms) to address a disease or other medical concern

Section 4: Case Study #1

A 33-year-old female named Alexa is experiencing increasing difficulty staying focused, managing anxiety, and meeting deadlines at work. She has a high-stress job as a project manager and is responsible for three large product lines at a major

organization. Alexa has the skills to excel at this job. She is an excellent planner and organizer with strong writing skills, which allow her to clearly convey herself in the many reports she needs to compile as part of her role. She does not have any physical health problems and continually gets good reports when she meets with her primary care physician for her yearly physical.

Alexa was recently diagnosed with Autism Spectrum Disorder and Attention-Deficit/Hyperactivity Disorder, leading her to begin weekly counseling sessions with a licensed mental health provider. In an effort to obtain better awareness of her bodily signals, Alexa is practicing identifying them at various times throughout the day regardless of how she feels. After three months in therapy, Alexa is more often able to pick up on her bodily signals early on, but she still tends to have difficulty pinpointing what they mean and using the right strategies to address them.

1. The case study mentions that Alexa is better able to pick up on her bodily signals early on. What type of interoception is this?
2. Alexa is continuing to have difficulty accurately identifying what various signals mean and managing them. What type of interoception does she still need to improve upon?
3. Let's say Alexa begins to feel chest tightness and nausea leading up to her performance review as well as a major meeting to present work she had been doing for months on end. Is it possible that anxiety is the cause of these bodily signals?
4. Based on what the above body signals might mean, what strategies are the most appropriate for Alexa to use to manage how she is feeling in that moment?

5. Are there strategies Alexa may be able to use on a regular basis to manage how she is feeling?

Section 5: Case Study #1 Review

This section will review the case studies that were previously presented.

Responses will guide the clinician through a discussion of potential answers as well as encourage reflection.

1. The case study mentions that Alexa is better able to pick up on her bodily signals early on. What type of interoception is this?

Interoceptive awareness

2. Alexa is continuing to have difficulty accurately identifying what various signals mean and managing them. What type of interoception does she still need to improve upon?

Interoceptive accuracy

3. Let's say Alexa begins to feel chest tightness and nausea leading up to her performance review as well as a major meeting to present work she had been doing for months on end. Is it possible that anxiety is the cause of these bodily signals?

Since Alexa is physically in good health, it's very likely these bodily signals are due to anxiety.

4. Based on what the above body signals might mean, what strategies are the most appropriate for Alexa to use to manage how she is feeling in that moment?

Alexa can use deep breathing strategies and progressive muscle relaxation to relieve some of the muscular tension she is experiencing. In terms of nausea, this is likely also due to anxiety. It's possible that breathing strategies and progressive muscle relaxation will help manage the nausea as well. However, after implementing them initially, she should do a body scan to determine any remaining concerns.

5. Are there strategies Alexa may be able to use on a regular basis to manage how she is feeling?

Journaling and tracking emotions are both great ways to manage anxiety that occurs regularly. These are each a good starting point for Alexa and can easily be added into her daily routine. Since Alexa has great writing skills, this is a great way to capitalize on her strengths and use at least portions of her existing skills to improve her health. Once she makes these into a habit, she can relay some of her findings to her therapist and they can work together to determine what other management strategies (if any) can help her.

Section 6: Case Study #2

An 8-year-old child named Jameson, who has Sensory Processing Disorder, presents to OT with fine motor delays, limited body awareness, and behavioral challenges. The child's parents and teachers consistently report that Jameson is disruptive in class and has a limited attention span. He has been receiving school-based OT for a year now and that provider determined that he is hyper-sensitive to auditory and visual input.

Jameson has good communication skills and frequently reports that his eyes are tired and he gets dizzy throughout the day. His teacher notes that this happens

the most often when he is asked to read or write, and that when he reports these concerns, he most often demonstrates behavioral concerns shortly after.

1. Is it possible that Jameson has deficits in interoception or are his concerns more likely related to his other sensory issues? Why or why not?
2. If Jameson does have interoception delays, is it possible to address those concerns within a school setting? If not, where would those concerns be better addressed?
3. What interoception skill does Jameson currently appear to have?
4. What interoception skill does Jameson currently appear to lack?
5. What strategies and interventions might Jameson benefit from in a school setting?
6. Would it benefit Jameson to also practice these strategies outside of school? Why or why not?

Section 7: Case Study #2 Review

This section will review the case studies that were previously presented. Responses will guide the clinician through a discussion of potential answers as well as encourage reflection.

1. Is it possible that Jameson has deficits in interoception or are his concerns more likely related to his other sensory issues? Why or why not?

Since it's common for people with sensory concerns to experience 'pain points' with more than one type of input, it's definitely possible that Jameson also has some deficits in interoception. He not only discusses bodily signals that are indicative of strong nervous system responses, but his

parents and teacher report behavioral concerns that could point toward difficulties with emotion regulation. Without assessing him fully, it's hard to definitively say he has interoception concerns, but it does seem like a possibility.

2. If Jameson does have interoception delays, is it possible to address those concerns within a school setting? If not, where would those concerns be better addressed?

Since his teacher is making some of these reports, it is not only possible, but appropriate to address these concerns at school. School-based services can potentially help Jameson's participation in the classroom. The case study also mentions that his parents have some of the same concerns, which means Jameson's family will likely benefit from parent training to assist in carrying his new skills over to the home.

3. What interoception skill does Jameson currently appear to have?

Based on the information provided, it seems that Jameson has good interoceptive accuracy because he is pointing out bodily signals that end up leading to behavioral problems.

4. What interoception skill does Jameson currently appear to lack?

It's possible that Jameson has difficulty knowing what to do about bodily signals once he becomes aware of them. While he can communicate his concerns to others, he seems to not be able to manage them himself.

5. What strategies and interventions might Jameson benefit from in a school setting?

Since Jameson demonstrates good communication skills, he may benefit from mental health support to address emotion dysregulation. This may be

formal by meeting with a mental health counselor in a school setting, but will likely be most effective when provided by various individuals (e.g., his parents, teacher, other adults) in the settings he is already used to. Some strategies that can assist this student include journaling and creating/ following a sensory diet with various preferred calming and regulating activities. In particular, Jameson may benefit from practicing body scans, guided imagery, and simple yoga poses that allow him to close his eyes (to lessen visual fatigue) as he focuses on calming himself and relieving any discomfort he is feeling. Jameson may also be a good fit for Cognitive Behavioral Therapy, which can be integrated into mental health services (if he receives any) or more briefly to develop various affirmations and mantras for him to use in times of high stress.

6. Would it benefit Jameson to also practice these strategies outside of school? Why or why not?

Yes. In fact, this is essential to carrying over interoception skills in other contexts. While Jameson seems to have the most difficulty with this problem at school, his parents are still reporting some concerns at home. Therefore, he would benefit from practicing strategies in various settings to assist his functioning. In addition, this will help him with long-term knowledge and use of the skill, which he can then apply to other contexts and situations that may arise in the future.

Section 8: Case Study #3

A 75-year-old woman named Susanne sustained a cerebrovascular accident 1 week ago. She was recently moved from the hospital to short-term rehab since the extent of her deficits prevented her from being discharged straight to her home. Susanne has had some motor deficits (mostly in her left leg) since her

stroke, but most of the symptoms she is dealing with are sensory and cognitive in nature. Nursing home staff report she is a high safety risk, frequently attempting to get out of bed and use the bathroom without assistance. She also has difficulty during showers, often telling the aides that the water is too hot or too cold even when they adjust it.

Prior to her injury, Susanne was living independently and exhibited no cognitive concerns. Her medical history consists of diabetes type 2 and hypertension. Since being admitted to rehab, Susanne's blood glucose levels have been unstable. Nursing staff attempted to discuss Susanne's diabetes with her – including the treatment she is receiving and how well controlled the condition is – but she wasn't able to give any reliable information due to her cognitive impairments. They asked her adult daughter instead, who reported that Susanne only sporadically tested her levels and often told her that she was able to sense when her blood glucose was either high or low.

Her daughter, who lives nearby and sees her mother multiple times per week, notes that she never saw her mother watch her diet. While they are close and discuss other sensitive matters, her daughter reports that Susanne never complained about any aspect of her physical or emotional health. However, her daughter reports frequent irritable outbursts and lability were a common occurrence with her mother.

1. Based on the information given, what is your clinical opinion on Susanne's interoception skills before her stroke?
2. Based on the information given, do you have reason to believe that Susanne's interoception skills have worsened since her stroke?

3. There are several contributing factors that have likely led Susanne to be labeled a high safety risk at the nursing facility. What are some of these factors?
4. What interoception interventions or strategies, if any, might Susanne benefit from?
5. Can any of these interventions or strategies be carried over to the home environment once Susanne is discharged?

Section 9: Case Study #3 Review

This section will review the case studies that were previously presented. Responses will guide the clinician through a discussion of potential answers as well as encourage reflection.

1. Based on the information given, what is your clinical opinion on Susanne's interoception skills before her stroke?

It appears that Susanne had impaired interoception skills before her stroke. This is based on her infrequent blood glucose monitoring habits, lability, and presently unstable blood glucose levels.

2. Based on the information given, do you have reason to believe that Susanne's interoception skills have worsened since her stroke?

Yes, it is quite possible that her interoception skills have worsened in the past week. Since the stroke mostly affected her cognition and sensation, it is likely that Susanne has even poorer interoception as well as impaired insight into her current condition.

3. There are several contributing factors that have likely led Susanne to be labeled a high safety risk at the nursing facility. What are some of these factors?

Susanne's leg range of motion, impaired insight, limited safety awareness, and interoception are likely all playing a part in her status as a safety risk.

4. What interoception interventions or strategies, if any, might Susanne benefit from?

Susanne would likely benefit from sponge baths to assist with feeling more comfortable during bathing. She would also benefit from visual reminders to call the nurse if she wants to get up, reposition, or use the bathroom. Once rehabilitated, if Susanne's cognition returns to baseline, a visual schedule would also be beneficial to outline the bodily and emotional signs of hyperglycemia and hypoglycemia. This can help better manage her diabetes and overall well-being as well as her emotional health. In addition to these signals, Susanne should work with someone (her daughter or a therapist) to create an action plan for when she notices these signs. Some for hypoglycemia may include having something to eat or drink (with examples listed including a cup of orange juice, several glucose tablets, or a spoonful of honey), sitting to rest, and doing deep breathing to manage fatigue, shortness of breath, or dizziness that may result. For hyperglycemia, techniques may include drinking a cup of water, taking insulin or medication as instructed, and doing body scans or other relaxation strategies to monitor the effect of those strategies.

5. Can any of these interventions or strategies be carried over to the home environment once Susanne is discharged?

Yes, most of these should be carried over to improve Susanne's long-term interoception.



References

1. Cleveland Clinic. (2025). Interoception. Retrieved from <https://my.clevelandclinic.org/health/articles/interoception>
2. Chen, W. G., Schloesser, D., Arensdorf, A. M., Simmons, J. M., Cui, C., Valentino, R., Gnadt, J. W., Nielsen, L., Hillaire-Clarke, C. S., Spruance, V., Horowitz, T. S., Vallejo, Y. F., & Langevin, H. M. (2021). The emerging science of interoception: Sensing, integrating, interpreting, and regulating signals within the self. *Trends in Neurosciences*, 44(1), 3–16. <https://doi.org/10.1016/j.tins.2020.10.007>
3. Schmitt, C. M., & Schoen, S. (2022). Interoception: A multi-sensory foundation of participation in daily life. *Frontiers in Neuroscience*, 16, 875200. <https://doi.org/10.3389/fnins.2022.875200>
4. Chen, W. G., & Langevin, H. M. (2025). Interoception as a central mechanism in Whole Person Health. *PLoS Biology*, 23(11), e3003487. <https://doi.org/10.1371/journal.pbio.3003487>
5. Barrett, L. F., & Quigley, K. S. (2021). Interoception: The secret ingredient. *Cerebrum : the Dana forum on brain science*, 2021, cer-06-21.
6. Smith, L. K., & PLOS Biology staff editors (2025). The body sends a signal: Perspectives on interoception. *PLoS biology*, 23(11), e3003517. <https://doi.org/10.1371/journal.pbio.3003517>
7. Singer, J., & Damasio, A. (2025). The physiology of interoception and its adaptive role in consciousness. *Philosophical transactions of the Royal Society of London. Series B, Biological sciences*, 380(1939), 20240305. <https://doi.org/10.1098/rstb.2024.0305>
8. Basinger, H., & Hogg, J.P. (2025). Neuroanatomy, Brainstem. [Updated 2023]

- Jul 4]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK544297/>
9. Shahid, Z., Asuka, E., & Singh, G. (2022). Physiology, Hypothalamus. [Updated 2021 May 9]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2021 Jan-. Available <https://www.ncbi.nlm.nih.gov/books/NBK535380/>
 10. Torrico, T.J., & Munakomi, S.. Neuroanatomy, Thalamus. [Updated 2023 Jul 24]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK542184/>
 11. Brockett, A. T., & Roesch, M. R. (2021). Anterior cingulate cortex and adaptive control of brain and behavior. *International Review of Neurobiology*, 158, 283–309. <https://doi.org/10.1016/bs.irn.2020.11.013>
 12. Karaivazoglou, K., Aggeletopoulou, I., & Triantos, C. (2024). Interoceptive processing in functional gastrointestinal disorders. *International Journal of Molecular Sciences*, 25(14), 7633. <https://doi.org/10.3390/ijms25147633>
 13. Klein, M., Witthöft, M., & Jungmann, S. M. (2025). Interoception in individuals with autism spectrum disorder: a systematic literature review and meta-analysis. *Frontiers in Psychiatry*, 16, 1573263. <https://doi.org/10.3389/fpsyt.2025.1573263>
 14. Göz Tebrizcik, B., Georgescu, A.L., Pick, S., & Dommett, E.J. (2025). Interoceptive abilities in adults with attention deficit hyperactivity disorder. *Biological Psychology*, 202, 109161. <https://doi.org/10.1016/j.biopsycho.2025.109161>
 15. Clemente, R., Murphy, A., & Murphy, J. (2024). The relationship between

self-reported interoception and anxiety: A systematic review and meta-analysis. *Neuroscience & Biobehavioral Reviews*, 167, 105923. <https://doi.org/10.1016/j.neubiorev.2024.105923>.

16. Horsburgh, A., Summers, S. J., Lewis, A., Keegan, R. J., & Flood, A. (2024). The relationship between pain and interoception: A systematic review and meta-analysis. *The Journal of Pain*, 25(7), 104476. <https://doi.org/10.1016/j.jpain.2024.01.341>
17. Kumar, M. A., & G, S. (2024). Effectiveness of interoceptive programs to improve academic self-regulation and reduce behavioral problems among children with learning disabilities. *Cureus*, 16(6), e61816. <https://doi.org/10.7759/cureus.61816>
18. Jenkinson, P.M., Fotopoulou, A., Ibanez, A., & Rossell, S. (2024). Interoception in anxiety, depression, and psychosis: A review. *The Lancet*, 73, 102673. DOI: [10.1016/j.eclinm.2024.102673](https://doi.org/10.1016/j.eclinm.2024.102673)
19. Hogeveen, J., & Grafman, J. (2021). Alexithymia. *Handbook of Clinical Neurology*, 183, 47–62. <https://doi.org/10.1016/B978-0-12-822290-4.00004-9>
20. NovoPsych. (n.d.). Multidimensional Assessment of Interoceptive Awareness – Version 2 (MAIA-2). Retrieved from <https://novopsych.com/assessments/formulation/multidimensional-assessment-of-interoceptive-awareness-version-2-maia-2/>
21. National Council on Aging. (2025). Mental Illness and Older Adults: What to Know About Symptoms and Treatment. Retrieved from <https://www.ncoa.org/article/mental-illness-and-older-adults-what-to-know-about-symptoms-and-treatment/>

22. Ulus, G., & Aisenberg-Shafran, D. (2022). Interoception in old age. *Brain Sciences*, 12(10), 1398. <https://doi.org/10.3390/brainsci12101398>
23. Haustein, M., Thomas, E. B. K., Scheer, K., & Denburg, N. L. (2024). Interoception, affect, and cognition in older adults. *Experimental Aging Research*, 50(3), 279–295. <https://doi.org/10.1080/0361073X.2023.2183704>
24. Carr, L., Donaghy, R., & Brewer, R. (2024). Interoception across the lifespan. In J. Murphy & R. Brewer (Eds.), *Interoception: A comprehensive guide* (pp. 317–355). Springer Nature Switzerland AG. https://doi.org/10.1007/978-3-031-68521-7_10
25. Pasciucco, M.R., Nunziata, S., Iuliano, S., Perrucci, M.G., Costantini, M., Ruggiero, G., & Ferri, F. (2026). Impact of interoception and multisensory integration on functional and physical activities in aging. *Cortex*, 194, 107-120. <https://doi.org/10.1016/j.cortex.2025.11.010>.
26. Goodall, E. (2021). Facilitating interoceptive awareness as a self-management and self-regulation tool to increase engagement in learning and education (Doctoral dissertation, University of Southern Queensland). Retrieved from <https://eprints.usq.edu.au/42829/1/Emma%20GOODALL%20thesis%20final.pdf>
27. Kolacz, J., Chen, X., Nix, E. J., Roath, O. K., Holmes, L. G., Tokash, C., Porges, S. W., & Lewis, G. F. (2023). Association of self-reported autonomic symptoms with sensor-based physiological measures. *Psychosomatic Medicine*, 85(9), 785–794. <https://doi.org/10.1097/PSY.0000000000001250>
28. Traumatic Stress Research Consortium (TSRC). (n.d.). The Body Perception Questionnaire. Retrieved from <https://www.traumascience.org/body-perception-questionnaire>

29. Vig, L., Köteles, F., & Ferentzi, E. (2022). Questionnaires of interoception do not assess the same construct. *PloS one*, 17(8), e0273299. <https://doi.org/10.1371/journal.pone.0273299>
30. Addabbo, M., & Milani, L. (2025). Measuring interoception from infancy to childhood: A scoping review. *Neuroscience & Biobehavioral Reviews*, 173, 106161. <https://doi.org/10.1016/j.neubiorev.2025.106161>.
31. Tanaka, Y., Ito, Y., Shibata, M. Terasawa, Y., & Umeda, S. (2025). Heartbeat evoked potentials reflect interoceptive awareness during an emotional situation. *Sci Rep*, 15, 8072. <https://doi.org/10.1038/s41598-025-92854-4>
32. Gautier, R., Latinus, M., & Briend, F. (2025). Characterizing the Heartbeat-Evoked Potential: A two-component model of cardiac signal processing?. *Psychophysiology*, 62(12), e70206. <https://doi.org/10.1111/psyp.70206>
33. Dunn, W., Brown, C., Breitmeyer, A., & Salwei, A. (2022). Construct validity of the Sensory Profile Interoception Scale: Measuring sensory processing in everyday life. *Front. Psychol*, 13, 872619. doi: 10.3389/fpsyg.2022.872619
34. Brown, C., & Dunn, W. (2023). Development of a participation focused measure of interoception for adults. *OTJR : occupation, participation and health*, 43(2), 264–270. <https://doi.org/10.1177/15394492221112651>
35. Price, C. J., Pike, K. C., & Merrill, J. O. (2025). Longitudinal effects of interoceptive awareness training as an adjunct to medication treatment for opioid use disorder: A randomized clinical trial of Mindful Awareness in Body-oriented Therapy. *Drug and alcohol dependence*, 275, 112813. <https://doi.org/10.1016/j.drugalcdep.2025.112813>
36. Hansen, K. A., Abu-Rish Blakeney, E., & Price, C. J. (2025). Implementation Outcomes From a Pilot Study of Mindful Awareness in Body-Oriented Therapy (MABT) as a Chronic Pain Treatment Modality in an Integrative

Health Clinic. *Global advances in integrative medicine and health*, 14, 27536130251319244. <https://doi.org/10.1177/27536130251319244>

37. Dunn, W., & Brown, C. (2023). Construct validity of the Sensory Profile Interoception. *Am J Occup Ther*, 77(Supplement_2), 7711500001p1. doi: <https://doi.org/10.5014/ajot.2023.77S2-RP1>
38. Lynch, A., Compton, R., Frost, C., Mikulis, T., & Shudrenko, D. (2025). Using EEG to explore brain wave activity during focused interoception awareness experiments. *Am J Occup Ther*, 79(Supplement_2), 7911500341p1. doi: <https://doi.org/10.5014/ajot.2025.79S2-PO329>
39. Poerio, G. L., Klabunde, M., Bird, G., & Murphy, J. (2024). Interoceptive attention and mood in daily life: An experience-sampling study. *Philosophical transactions of the Royal Society of London. Series B, Biological sciences*, 379(1908), 20230256. <https://doi.org/10.1098/rstb.2023.0256>
40. Tan, Y., Wang, X., Blain, S. D., Jia, L., & Qiu, J. (2023). Interoceptive attention facilitates emotion regulation strategy use. *International Journal of Clinical and Health Psychology : IJCHP*, 23(1), 100336. <https://doi.org/10.1016/j.ijchp.2022.100336>
41. Mulder, J., Boelens, M., Van der Velde, L. A., Brust, M., & Kieffe-de Jong, J. C. (2024). The role of interoception in lifestyle factors: A systematic review. *The European Journal of Public Health*, 34(Suppl 3), ckae144.590. <https://doi.org/10.1093/eurpub/ckae144.590>
42. Price, C. U., Pike, K. C., Treadway, A., Palmer, J., & Merrill, J. O. (2024). Immediate Effects of Mindful Awareness in Body-oriented Therapy as an Adjunct to Medication for Opioid Use Disorder. *Research Square*, rs.3.rs-4727162. <https://doi.org/10.21203/rs.3.rs-4727162/v1>

43. Sun, Q., Shen, X., Qi, M., Suliman, M., & Tian, S. (2024). The Mediating Role of Interoceptive Sensitivity in the Relationship between Physical Activity and Depression Symptoms in College Students. *Behavioral sciences (Basel, Switzerland)*, 14(7), 608. <https://doi.org/10.3390/bs14070608>
44. Santamaría-García, H., Migeot, J., Medel, V., Hazelton, J. L., Teckentrup, V., Romero-Ortuno, R., Piguet, O., Lawor, B., Northoff, G., & Ibanez, A. (2025). Allostatic interoceptive overload across psychiatric and neurological conditions. *Biological Psychiatry*, 97(1), 28–40. <https://doi.org/10.1016/j.biopsych.2024.06.024>
45. Knisely, J., & McLaughlin, E. (2025). OT strategies to increase interoceptive awareness and sensory processing among nonspeaking pediatric clients. *Am J Occup Ther*, 79(Supplement_2), 7911500103p1. doi: <https://doi.org/10.5014/ajot.2025.79S2-PO99>
46. Mahler, K., Hample, K., Jones, C., Sensenig, J., Thomasco, P., & Hilton, C. (2022). Impact of an interoception-based program on emotion regulation in autistic children. *Occupational Therapy International*, 9328967. <https://doi.org/10.1155/2022/9328967>
47. Pasciucco, M. R., Nunziata, S., Iuliano, S., Perrucci, M. G., Costantini, M., Ruggiero, G., & Ferri, F. (2026). Impact of interoception and multisensory integration on functional and physical activities in aging. *Cortex; a journal devoted to the study of the nervous system and behavior*, 194, 107–120. <https://doi.org/10.1016/j.cortex.2025.11.010>
48. Loureiro, F., Ringold, S. M., & Aziz-Zadeh, L. (2024). Interoception in Autism: A narrative review of behavioral and neurobiological data. *Psychology Research and Behavior Management*, 17, 1841–1853. <https://doi.org/10.2147/PRBM.S410605>

49. Bonete, S., Molinero, C., & Ruisanchez, D. (2023). Emotional Dysfunction and Interoceptive Challenges in Adults with Autism Spectrum Disorders. *Behavioral sciences (Basel, Switzerland)*, 13(4), 312. <https://doi.org/10.3390/bs13040312>
50. Joshi, V., Graziani, P., & Del-Monte, J. (2021). The Role of Interoceptive Attention and Appraisal in Interoceptive Regulation. *Frontiers in psychology*, 12, 714641. <https://doi.org/10.3389/fpsyg.2021.714641>
51. Pereira-Hudson, I.J., Camacho, V.M., Tsang-Wu, C., Robertson, H., Gallagher, V., & Provisor, j. (2024). Exploring interoception with adults: Occupational therapy practitioner knowledge, perceptions, and practice patterns. *Am J Occup Ther*, 78(Supplement_2), 7811500113p1. doi: <https://doi.org/10.5014/ajot.2024.78S2-PO113>
52. Foster, L., Mische Lawson, L., & Moreland, H. (2025). Impact of a responsive feeding intervention on children and caregivers: A nonrandomized, repeated-measures study. *Am J Occup Ther*, 79(5), 7905205060. doi: <https://doi.org/10.5014/ajot.2025.051100>
53. Barmpagiannis, P., & Baldimtsi, E. (2025). Interoception and emotional regulation in autistic children through an occupational therapy perspective: A literature review. *Brazilian Journal of Science*, 4(2). <https://doi.org/10.14295/bjs.v4i2.699>
54. Clark, E., Brown, T., & Yu, M. L. (2025). Interoception and its application to paediatric occupational therapy: A scoping review. *Australian Occupational Therapy Journal*, 72(1), e12997. <https://doi.org/10.1111/1440-1630.12997>
55. Grist, N., Yu, M. L., & Brown, T. (2025). Exploration of children's interoception, emotional regulation, or anxiety and occupational participation: A scoping review with narrative synthesis. *Occupational*

Therapy in Health Care, 1–23. Advance online publication. <https://doi.org/10.1080/07380577.2025.2567315>

56. McGreevy, S., & Boland, P. (2022). Touch: An integrative review of a somatosensory approach to the treatment of adults with symptoms of post-traumatic stress disorder. *European Journal of Integrative Medicine*, 54, 102168. <https://doi.org/10.1016/j.eujim.2022.102168>.
57. Bishop, C., Brown, T., & Yu, M. L. (2023). The relationship between school-age children's interoceptive awareness and executive functioning: An exploratory study. *The British Journal of Occupational Therapy*, 86(2), 116–129. <https://doi.org/10.1177/03080226221128184>





The material contained herein was created by EdCompass, LLC ("EdCompass") for the purpose of preparing users for course examinations on websites owned by EdCompass, and is intended for use only by users for those exams. The material is owned or licensed by EdCompass and is protected under the copyright laws of the United States and under applicable international treaties and conventions. Copyright 2026 EdCompass. All rights reserved. Any reproduction, retransmission, or republication of all or part of this material is expressly prohibited, unless specifically authorized by EdCompass in writing.