Aphasia Games for Health: rehab principles and design considerations from speech-language pathology

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Talk Outline:

1. Mini intro: what is aphasia? What is its impact?

2. What is aphasia rehabilitation?
   - Treatment goals: what do speech-language pathologists (SLPs) try to help change?
   - Typical aphasia treatment approaches.

3. Aphasia rehab and AGFH
   - Core behavioral parameters.
   - Additional rehab principles, active ingredients, and design considerations.

4. Game and aphasia treatment examples.

Introduction to aphasia:

- Aphasia is a language disorder caused by acquired brain injury, usually to the left hemisphere.

- ***At least 2.5 million people with aphasia (PWA)*** in the United States resulting from stroke, TBI,or brain tumor (Simmons-Mackie et al., 2018).

- Aphasia negatively affects **long-term quality of life**, leads to **social isolation,** and is associated with increased **depression** and **anxiety** (Simmons-Mackie et al., 2018).

- Low public awareness for aphasia and lack of long-term services. AGFH an exciting way to help this underserved population!
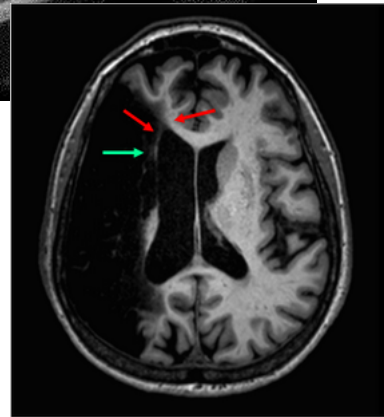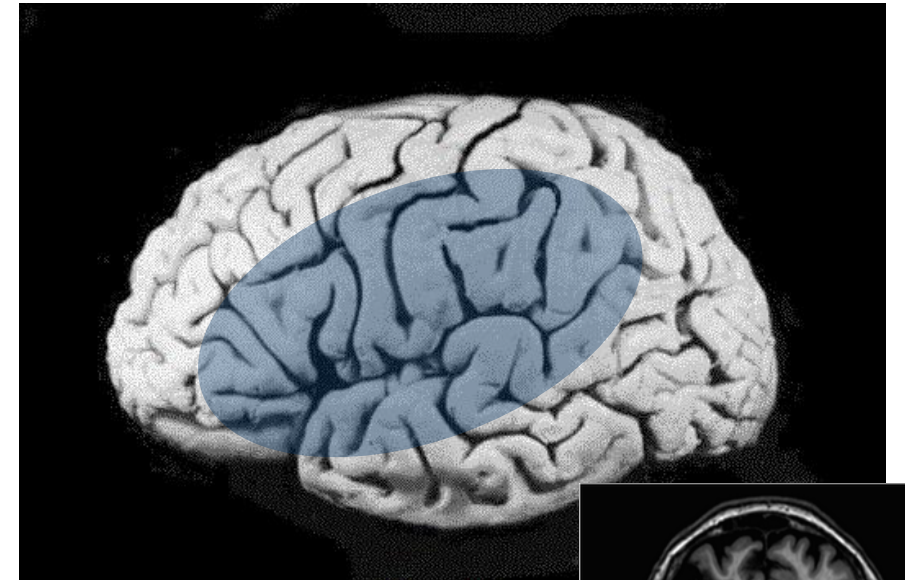
Aphasia is a disorder of language caused by brain damage, usually to the left hemisphere.

Aphasia can affect...

Talking

Listening Comprehension

Writing

Reading

Aphasia and the language system:

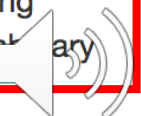- PWA can have difficulties in *any* area of language.

Input (comprehension):
- Can they understand...
  - Single words?
  - Sentences?
  - Books?
  - Conversation?

Output (production):
- Can they produce
  - Single words?
  - Sentences?
  - Written paragraphs?
  - Verbal monologue?

	Spoken Language		Written Language	
	Listening	**Speaking**	**Reading**	**Writing**
Phonology	ability to identify and distinguish phonemes while listening (i.e., phonological awareness)	appropriate use of phonological patterns while speaking	understanding of letter-sound associations while reading (i.e., phonics)	accurate spelling of words while writing
Morphology	understanding morphemes when listening	using morphemes correctly when speaking	understanding grammar while reading	appropriate use of grammar when writing
Syntax	understanding sentence structure elements when listening	using correct sentence structure elements when speaking	understanding sentence structure while reading	using correct sentence structure when writing
Semantics	listening vocabulary	speaking vocabulary	reading vocabulary	writing vocabulary

https://www.asha.org/Practice-Portal/Clinical-Topics/Spoken-Language-Disorders/Language-In--Brief/

Aphasia profiles are highly variable!

Key points:

- PWA each have their own **unique language profile**.
- PWA may have deficits across the board or only in one or two areas.
- Deficits may be mild in some areas but severe in others, or mild/severe across the board.

- To make fun and engaging games for the aphasia community, it's important to take this huge amount of *individual variability* into account!

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Semantics	listening vocabulary	speaking vocabulary	reading vocabulary	writing vocabulary

Examples: conversation with two people who have very different aphasia profiles:

- https://www.youtube.com/watch?v=3oef68YabD0
- https://www.youtube.com/watch?v=JWC-cVQmEmY

Language deficits are only *one* part of living with Aphasia:

- **How well does language ability, beliefs, and attitude match environment and communication needs?**

- *Life participation examples:*
  - Life roles, responsibilities, activities of choice.
  - Needing to serve as breadwinner? Advocate for their children at school?

- *Person-level examples:*
  - Attitude, beliefs, mental health.
  - Responding to communication difficulty with shame, depression, anxiety, and perfectionism vs. resilience, humor, and humility?

- *Communication environment examples:*
  - Physical and social environment.
  - Loud family gatherings where people interrupt and talk over each other vs. small support group where people have learned to provide each other space to contribute.
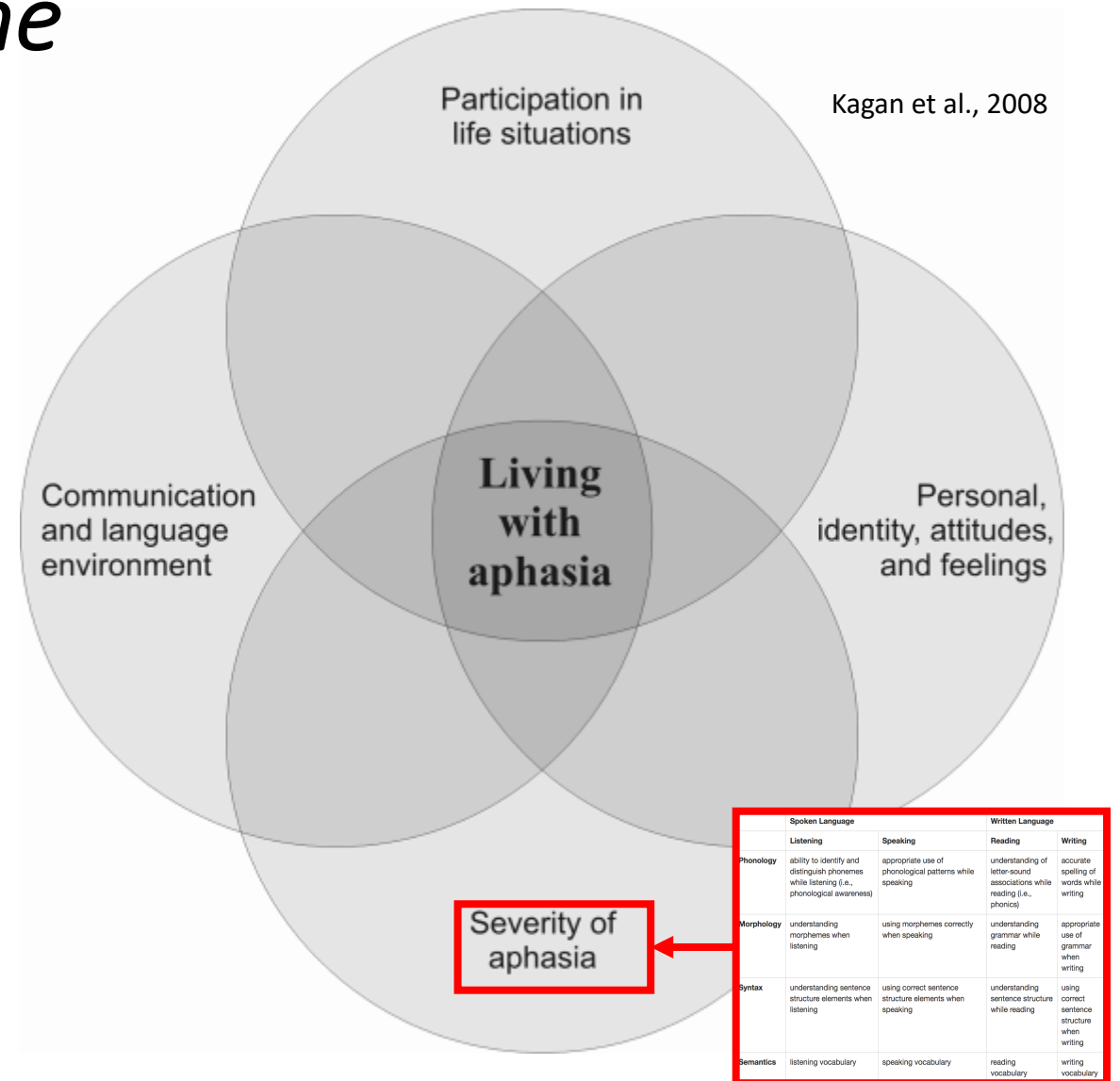
Aphasia affects the ability to satisfy **basic human needs**:

- Self-Determination Theory (Deci & Ryan 2000): Human beings have **three basic psychological needs.**

  1. **Autonomy:** the ability to act in accordance with our own values and wishes. The feeling that our actions are volitional or in accordance with our values.
  2. **Competence:** feeling effective, ability to master challenges and interact successfully with environment. Activity that is not personally meaningful does support the same feelings of competence.
  3. **Relatedness:** feeling connected to others.

- Aphasia challenges competence and autonomy, and can make it hard to connect with others.
- Well-designed Aphasia Games for Health could help address these basic needs.

Aphasia treatment goals from and SLP perspective:

1. Restore lost language ability:
   - Can target specific difficulties in reading, writing, understanding, speaking, numeracy, etc.

2. Improve compensatory communication skills:
   - Here, communication is the goal, not just one particular way to express a message.

3. Address linguistic, environmental, and psychosocial barriers to communication and living with aphasia.
   - A lot more can be done to help PWA than just focus on language deficits in isolation!

- These possibilities should inform our AGFH transformational design goals.
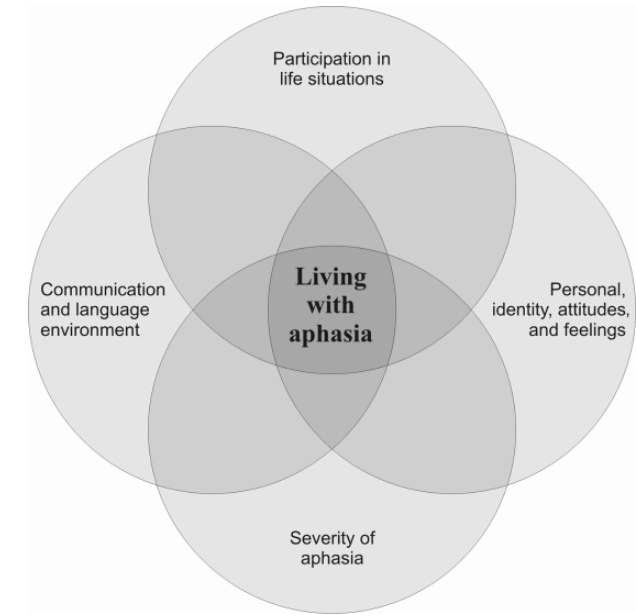
Types of aphasia treatment approaches:

1. Restorative treatment:
   - Directly improve language function via drilling, structured therapy, lots of repetition and practice.

2. Compensatory treatment:
   - Training self-cueing, and other compensatory communication strategies for people with aphasia **and** communication partners.

3. Counseling and other types of emotional support:
   - Addressing the emotional impact of aphasia.
   - Helping to promote psychological flexibility and resilience!

4. Education:
   - Better understanding of what does and doesn't work (and why!) helps PWA and caregivers work with the aphasia as it is.
   - Education is empowering and supports aphasia advocacy directly from the aphasia community!

Current aphasia treatments are well-aligned with AGFH:

- Standard aphasia treatments in current clinical practice are **behavioral** (i.e., drilling and practice seeking to change behavior).

- Why? The right behavioral treatments promote adaptation and restore lost function by promoting *state-dependent neuroplasticity.* (Kleim and Jones, 2008; Kiran and Thompson, 2019).

- Acquired brain injury causes aphasia, but practice can lead directly to changes in neural function.

- Great news for AGFH!

- Games shape behavior and can offer excellent practice contexts!

Applying key SLP rehab principles to AGFH:

- AFGH is a wide open exciting area for game adaptation and development. Many potential directions.

- For our summer 2020 prototyping, we need to narrow things down.

- We will be developing fun new games that…
  1. Are playable by the aphasia community through video teleconferencing software.
     - Need to maximize access during COVID19 and beyond.
     - Many PWA are isolated and have additional difficulties with mobility and transportation.
  2. Have one or more **clear therapeutic goals**.
     - Help PWA continue to improve and connect!
     - Designed to address language deficits and/or the negative consequences of living with aphasia.
  3. Ideally, are playable *without* the support of SLPs or other licensed healthcare professionals.
     - Why? Healthcare services for aphasia are very limited and short-term.
     - PWA have the ability to continue to improve for *years* after their treatment typically runs out.
     - We want to offer evidence-based options to promote long-term recovery outside the standard medical model.

AGFH prototype core design ingredients:

- **Most effective behavioral aphasia treatment include the following:**
  1. Provide repeated practice with clear intent.
  2. Provide performance feedback.
  3. Adjust task difficulty over time to maintain **desirable difficulty**.

- **Important to incorporate each of these ingredients in our AGFH prototype designs.**

1. Repeated practice with clear intent:

- For skill learning or performance improvements to be maintained long-term, *lots* of practice is required.

- Practice is often required past the point of initial mastery (e.g., 'overtraining').

- Clear therapeutic goals support deliberate practice and help maintain focus and improve dosage.

- Caveat: deliberate practice is good, self-consciousness is bad. Many aspects of language aren't under full conscious control…
  - To get an idea of this, try to explain a complicated idea while paying attention to exactly what your lips and tongue are doing.
  - Don't worry, the team will help set meaningful and helpful goals!

- ***Design challenge:*** typically, the more members in an aphasia group, the less practice opportunities for each member. Can you design ways for multiple players to get lots of repeated practice?

2. Performance feedback.

- When players get feedback about the success of their attempts, it promotes learning and retention.

- Easy to work into game design.

- *Note:* not all learning requires explicit feedback, but it's generally helpful and a useful design constraint. we want to focus on skills and abilities that benefit.

3. Adjust the task to maintain **desirable difficulty.**

- Finding the *right* balance between level of effort, task difficulty, and chance of success is important to maximize learning and successful behavioral change.

- The appropriate level of challenge is crucial to maintaining feelings of **competence** and overall player **motivation**.

- Increasing effort promotes better learning and retention, but producing too many errors increases frustration and can actually reduce learning performance.
  - "Errors learning" encodes error instead of correct performance, which can create learning interference in future practice.

- My lab has developed the ***BEARS*** treatment framework (Evans et al., 2020
  - "Balancing Effort, Accuracy, and Response Speed."
  - The sweet spot that balances these factors maintains desirable difficulty.

- ***Key design challenge:***
  - Remember, different PWA have **very different** language profiles and abilities.
  - Games may combine players who do and don't have aphasia.
  - How will your game maintain desirable difficulty for as many different types of players as possible, even as they improve their abilities over time?
  - Can you incorporate play asymmetry and adaptive elements?
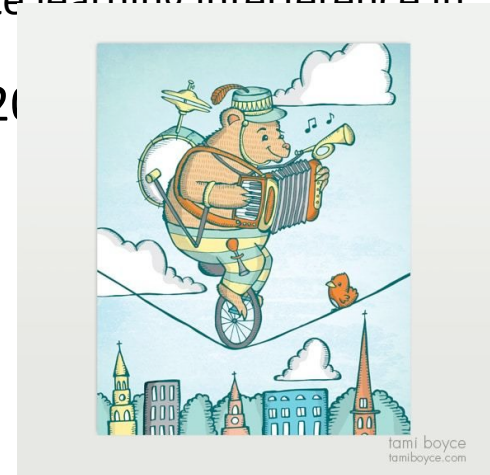
Cognitive-linguistic processing demands in AGFH:

- Regardless of exact therapeutic goal, it is important to consider players' cognitive-linguistic systems.

- Design with a **processing model** in mind.

- **In this moment of communication, for this individual…**
  - **What are their cognitive and linguistic processing demands?**
  - **What input or output are they trying to understand or produce?**
  - **Will this moment of processing succeed? Why or why not?**

https://woodgears.ca/marbles/paul.html

Task performance = Player ability + Task complexity:

- Two key capacities are part of player ability:
    1. Processing bandwidth
    2. Resolving processing interference

- May vary depending on domain and type of processing (e.g. visuospatial vs. verbal, semantic vs. phonological, etc.).

Bandwidth (limited processing capacity):

- *The gist:* only so much information can be consciously attended, actively remembered, or manipulated.
- AKA, attention capacity, short-term memory and working memory.

- Many PWA have limited bandwidth, especially for language.

- Bandwidth design considerations:
  - Amount of language? (e.g., sentence length)
  - How many game elements can your players pay attention to or hold in their heads at the same time?
  - *Note:* early on, game rules require lots processing bandwidth at first, but generally require less over time if they can be successfully acquired and automatized.

Resolving processing interference:

- Classic example- the **Stroop task.**

- PWA often show difficulty with semantic or phonological interference and.

- Will often make speech errors in these areas.

- Design consideration: can increase or decrease task interference based on game needs and player ability.

Incongruent trial

Congruent trial

BLUE

YELLOW

BLUE

GREEN

YELLOW   GREEN   YELLOW   BLUE

RED   RED   YELLOW

RED

BLUE   BLUE   RED

RED

GREEN   GREEN   GREEN

YELLOW

Note: Aphasia is a *language access* problem

- In post-stroke aphasia, underlying linguistic knowledge is thought to be intact, but PWA have difficulty **accessing**, **retrieving**, and/or **combining** key elements of language in the moment in a timely fashion, causing communication breakdown. (Hula and McNeil, 2008)

- Evidence: PWA often respond well to cues and/or priming, producing language they cannot otherwise produce on their own.

- This shows us that the underlying language is still available to be accessed with the right support and practice!

- Improving access to language in contexts of increasing independence is a key *mechanism of action* in aphasia rehab.

Linguistic design considerations:

- Remember levels and areas of potential language breakdown for PWA.

- **Input (comprehension):**
  - Can they understand…
    - Single words?
    - Sentences?
    - Books?
    - Conversation?

- **Output (production):**
  - Can they produce
    - Single words?
    - Sentences?
   - Written paragraphs?
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Linguistic design considerations:

Ways to modify task difficulty:

- Modify the performance goal (e.g., from 3-word to 5-word sentence).
- Modify stimuli complexity (e.g., length, amount of content, amount of interference).
- Modify pacing, processing speed, or time pressure.
- Modify level of support via cueing:
  - Semantic: clues for meaning ("it is a type of bird")
  - Phonological: clues for sounds ("starts with a 'p' sound", rhymes with "edible")
  - Providing parts of the target, or even the full target for repetition.
- Training strategies ("can you spell it instead?") or asking PWA to come up with their own ("how else can you communicate this?").

- **Desirable difficulty** requires finding ways to match task complexity with individual processing ability!
- There should be fun and dynamic ways to do this.

A helpful rehab design framework: the Rehabilitation Treatment Specification System

https://mrri.org/mrri-develops-rehab-treatment-specification-system/
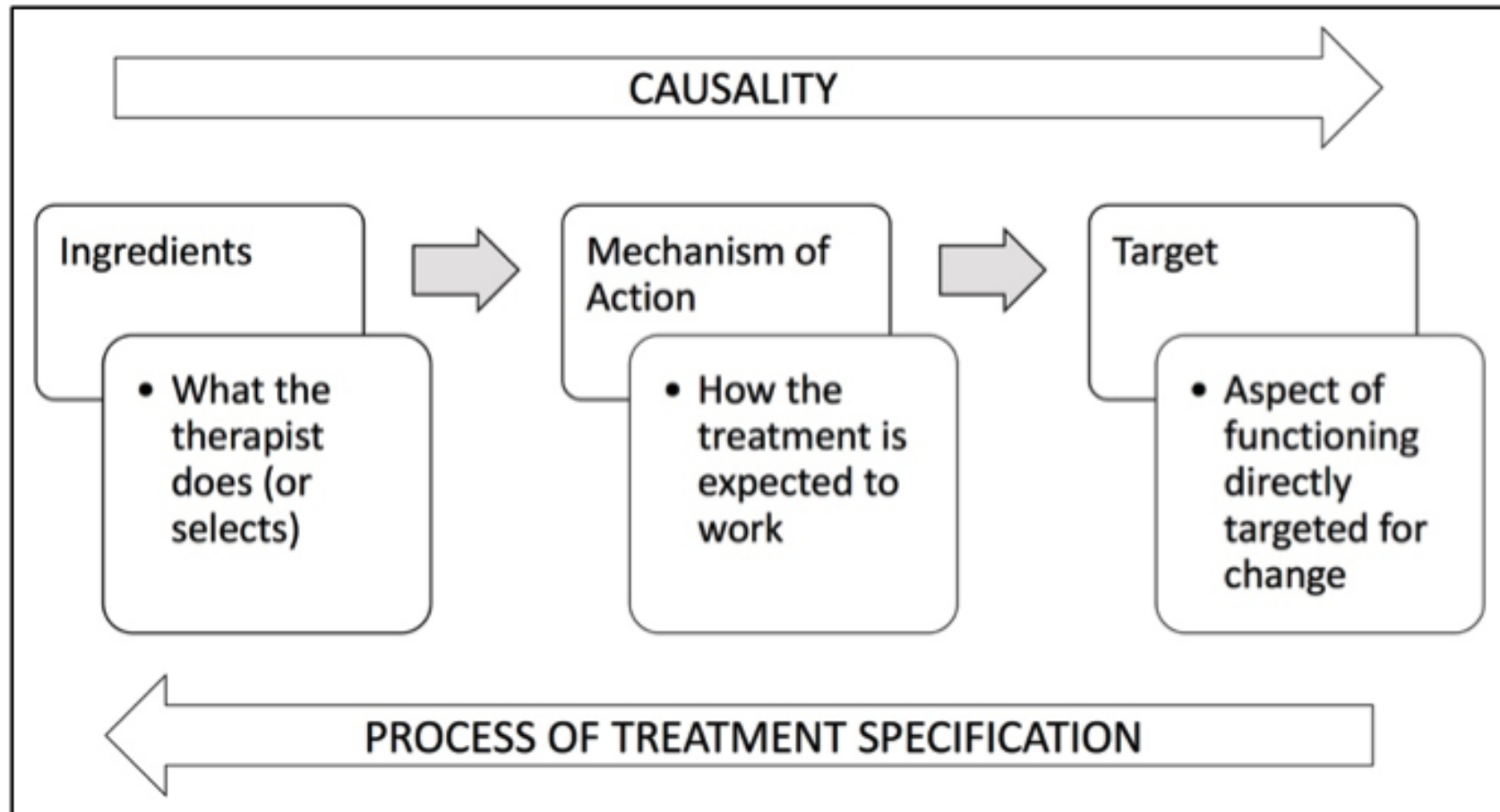
Language game case examples: word retrieval

- **Taboo:**
  - ***The gist-*** players need to get people on their team to guess a target without mentioning a number of highly related words.
  - How this creates desirable difficulty for people without aphasia:
    - High processing bandwidth requirements to remember what Not to say and use it to self-monitor performance.
    - Holding taboo words actively in memory leads to increased processing interference, harder to retrieve alternatives.
    - Rounds are timed, which further increases pressure and processing demand.
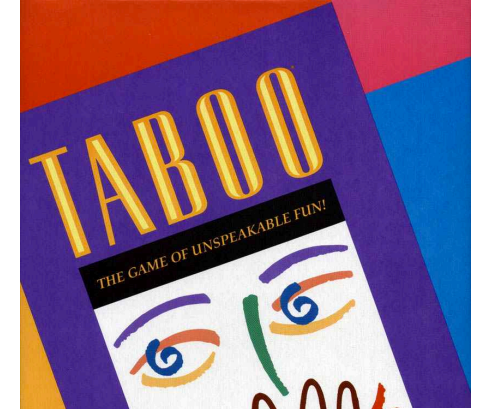
- **Anomia:**
  - ***The gist-*** players take turns drawing cards that have a symbol and a category, leaving them face up. When a player draws a card that matches the symbol of another player, they each race to name a word from the other player's category first.
  - How this creates desirable difficulty for people without aphasia:
    - Time pressure is created through inter-player competition.
    - Increased processing bandwidth comes from monitoring symbol matches (which can switch based on wild cards), while also thinking of categories.
    - Under this context, people without aphasia actually display the type of word finding difficulty (anomia) that PWA experience every day.

Response Elaboration Training (Kearns, 1985):

- **The gist:** the PWA is presented with a picture and begins to describe it. The SLP then asks elaborating questions and helps model and expand on their language to increase overall utterance length.

- **Treatment target:** improved spoken discourse production.

- **Ingredients:** clinician feedback, questions and expansion (input), opportunities for repetition, verbal output of PWA-initiated ideas and language.

- **Hypothesized mechanisms of action:**
  - Questions, expansions, and repetition keep pushing bandwidth limitations for utterance length.
  - Repeated practice for word retrieval in a loosely structured task with PWA-initiated productions is thought to more closely match natural conversation. Therefore thought to generalize better to natural conversation than more structured drill tasks.

- **Design challenge:** can you design a game where improvements generalize outside the game context?

- It is much easier to improve performance in a specific situation than it is to improve performance more broadly.

Constrain Induced Aphasia Therapy (Pulvermüller et al., 2001)

- ***The gist:***
  - Modified "go fish" game using visual barriers so that players cannot see one another's cards.
  - Players must name or describe the target card verbally, without using others means of communication such as gesture.
  - Cards may include semantic or phonological distracters.
  - Practice is typically intensive (e.g., 3 hours a day!).

- ***Treatment target:*** improve spoken production (could be single word or discourse depending on cards).

- ***Ingredients:*** barrier task, forced use of language, verbal comprehension and production, retrieval interference, intensive practice.

- ***Hypothesized mechanisms of action:***
  - Forced constrained use of language under intensive practice context thought to specifically target language system and overcome learned disuse.
  - However, evidence that similar treatments that allow for multiple modalities of expression (writing, gesture) may be equally effective (e.g., Rose et al., 2013)...

Aphasia rehab design take-aways:

- Provide gaming contexts that…
  - Provide repeated practice and performance feedback.
  - Maintain desirable difficulty.
  - Allow practice accessing / retrieving / combining key elements of language.
  - Allow practice resolving processing interference.
  - Let players work at the limits of processing capacity.

- Make sure your games are designed to help players:
  - Improving language function.
  - Learn better ways to adapt.
  - Otherwise address barriers to successfully living with aphasia.

Thank you for your interest in AGFH!

- *A fun and exciting way to help people with aphasia continue to **improve** and **connect**!*