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Motivation, Control and Hearing Loss-Related Fatigue

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- Stephen Camarata
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- Sasha Key



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Hearing Loss, Listening Effort and Fatigue

- Listening IS exhausting!!!
 - Post on hearingaidforums.com



- “...since I lost most of my hearing..., I've had periodic bouts of tiredness that are deeper and of a different quality than I ever experienced before.”
 - Copithorne, 2006



- “I go to bed most nights with nothing left. It takes so much energy to participate in conversations all day, that I'm often asleep within minutes.”
 - Blog post <http://hearingelmo.wordpress.com>



Fatigue- More than effort and task difficulty

High effort/difficulty \neq always lead to fatigue



Fatigue- More than effort and task difficulty

- Risk for fatigue increases in:
 - Mentally/physically challenging conditions
 - Requires effortful control to attain/maintain performance
 - Maintaining “acceptable” performance is difficult or not possible
 - Low control conditions
 - Timed or scheduled tasks with limited flexibility
 - Limited **ability** to modify the task characteristics
 - Important conditions
 - High motivation
 - Negative consequences for poor performance

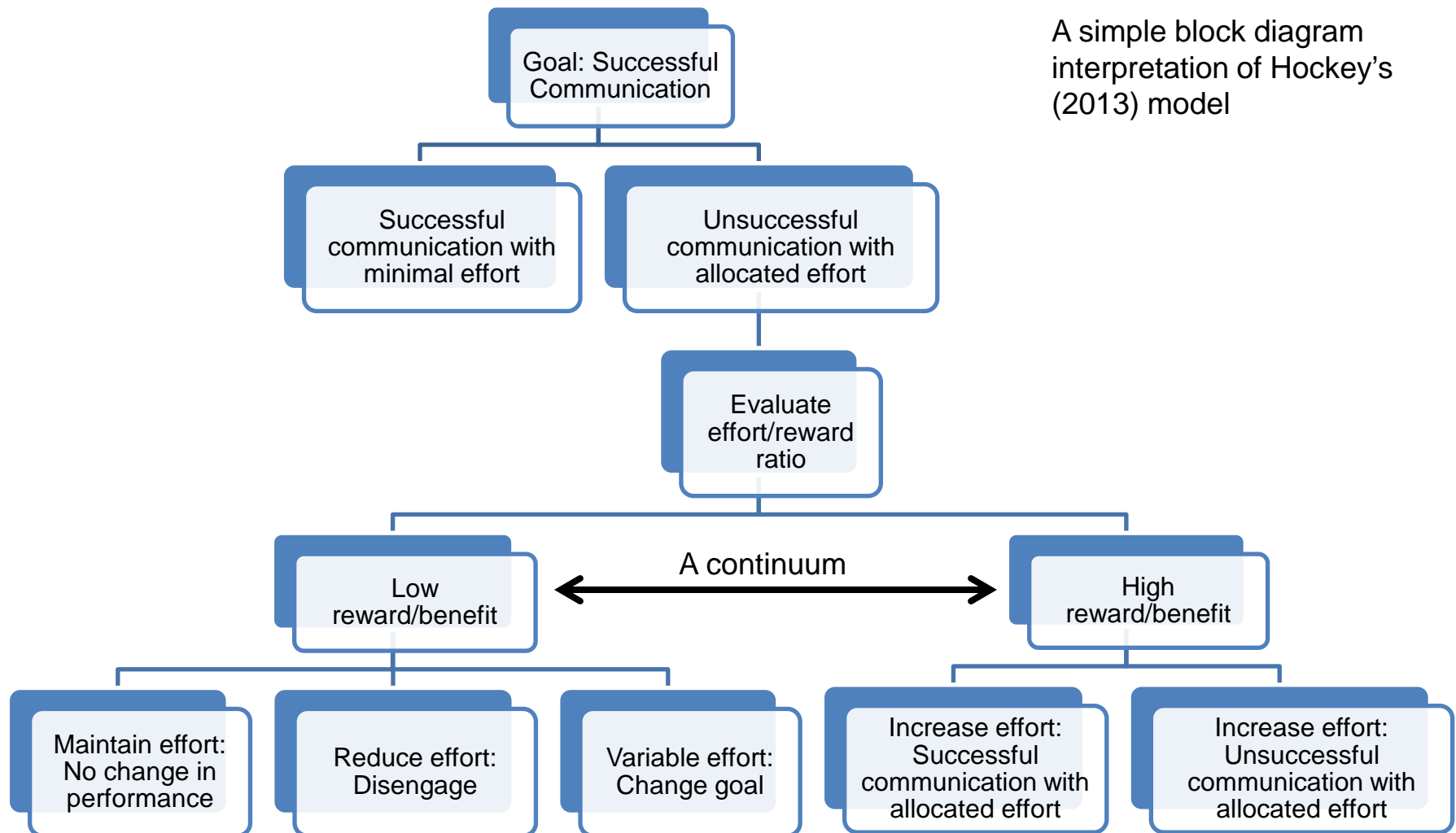
A motivational control theory of cognitive fatigue (Hockey, 2013)

- Fatigue is an emotional response serving an adaptive, goal-directed, function
 - forces us to evaluate current goal-directed behaviors in terms of an effort/reward balance
- Fatigue is a “protective” mechanism to help us decide if the effort applied towards a goal is worth the reward.



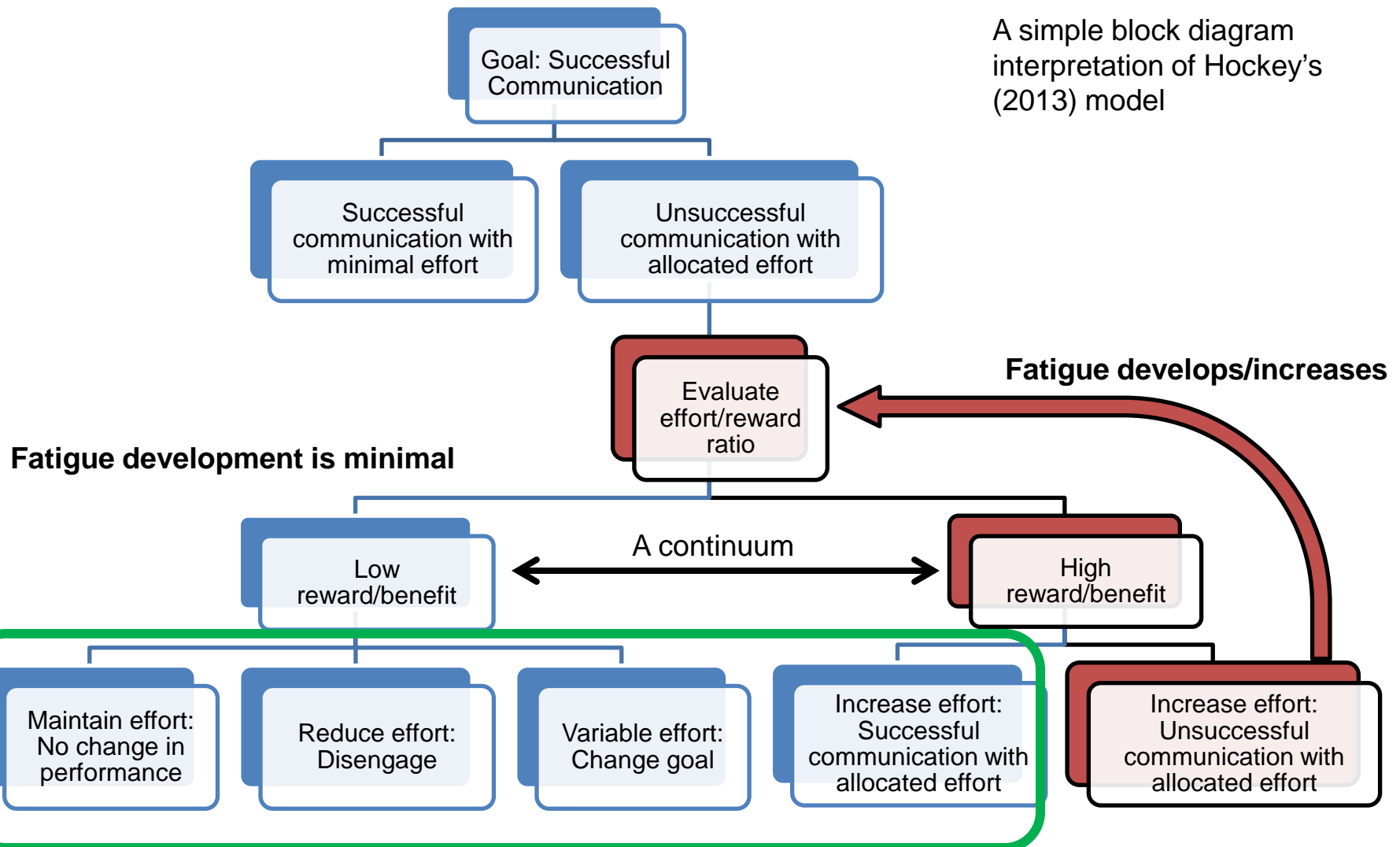
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A simple block diagram interpretation of Hockey's (2013) model



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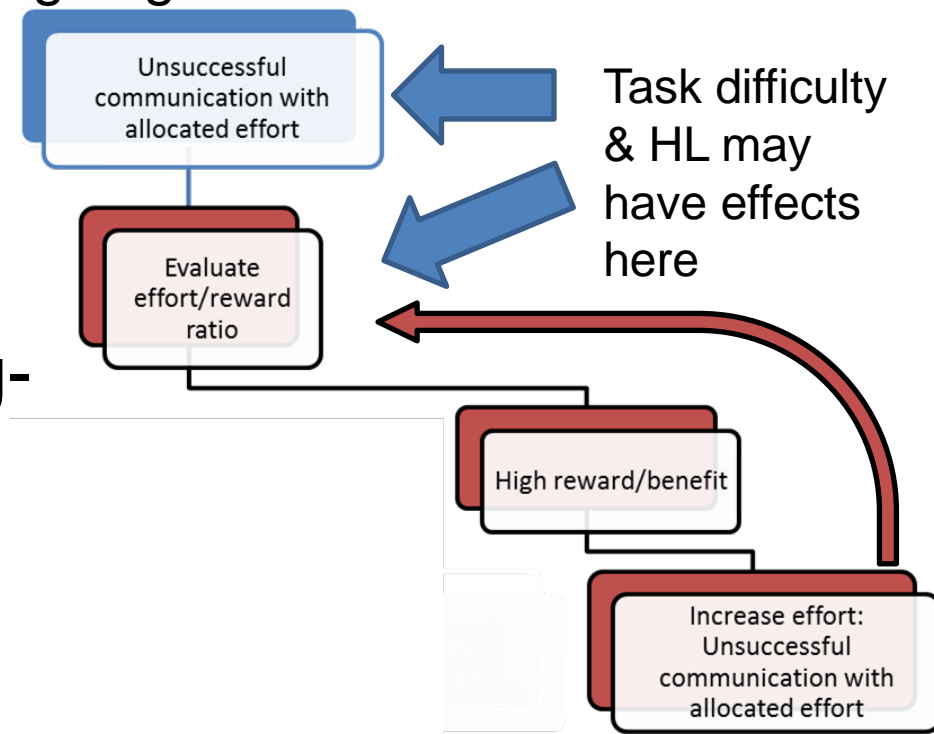


Model Predictions-

- Speech processing-related fatigue should be associated with task difficulty and hearing loss
 - Conditions where speech understanding is more difficult & effortful should be more fatiguing

- Degree of hearing loss would be associated with perceived effort and speech processing-related fatigue

- More hearing loss -> more difficulties-> more effort -> more fatigue



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Assessing speech-processing related fatigue in the laboratory

1. Does task difficulty or hearing loss modulate effort and speech-processing related fatigue?
2. Does degree of hearing loss modulate effort and speech-processing related fatigue?



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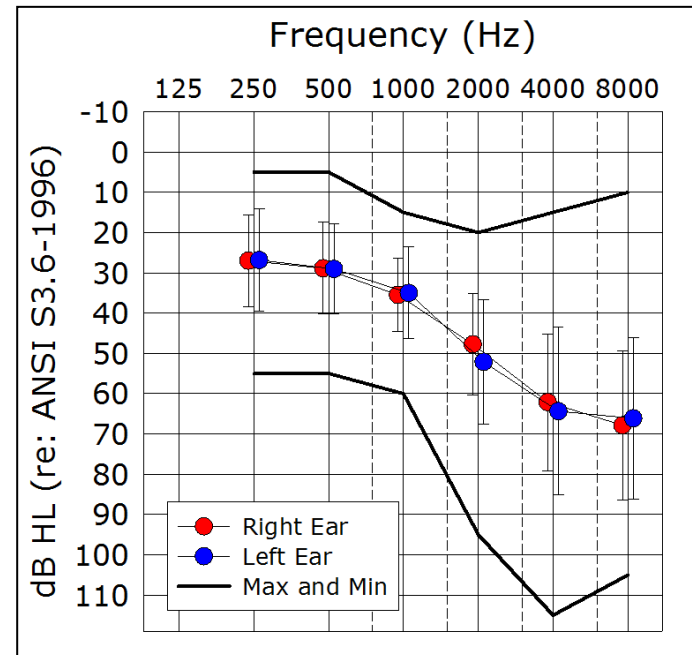
PARTICIPANTS AND PROCEDURES



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Participants

- Young normal hearing adults (N = 50)
 - Mean age = 24 years
 - range 18-32 years
- Older adults with hearing loss (N=31)
 - Mean age = 71 years
 - range 63-79 years
 - Mean PTA = 35.6 dB
 - range 25-53 dB
 - All hearing aid users
 - All tested **unaided**



“Listening IS exhausting!!”



Speech Fatigue Task (SFT)

What Color was Charlie?

Call Signs

Arrow

Baron

Charlie

Eagle

Hopper

Laker

Ringo

Tiger

ALERT

Color

Blue

Green

Red

White

ALERT

Number

1

2

3

4

5

6

7

8

Ready Charlie go to Blue 1 now → Ready Eagle go to Green 4 now

“Listening IS exhausting!!”



Speech Fatigue Task (SFT)

What CallSign was One?

Call Signs

Arrow

Baron

Charlie

Eagle

Hopper

Laker

Ringo

Tiger

ALERT

Color

Blue

Green

Red

White

ALERT

Number

1

2

3

4

5

6

7

8

Ready Charlie go to Blue 1 now → Ready Eagle go to Green 4 now

“Listening IS exhausting!!”



Speech Fatigue Task (SFT)

What Number was Green?

Call Signs

Arrow

Baron

Charlie

Eagle

Hopper

Laker

Ringo

Tiger

ALERT

Color

Blue

Green

Red

White

ALERT

Number

1

2

3

4

5

6

7

8

Ready Charlie go to Blue 1 now → Ready Eagle go to Green 4 now

“Listening IS exhausting!!”

A control panel interface with several sections:

- Call Signs:** A horizontal row of eight buttons labeled Arrow, Baron, Charlie, Eagle, Hopper, Laker, Ringo, and Tiger.
- Color:** A horizontal row of four buttons labeled Blue, Green, Red, and White. The Blue, Green, and Red buttons are colored to match their labels, while the White button is white.
- Number:** A horizontal row of eight buttons labeled 1, 2, 3, 4, 5, 6, 7, and 8.
- Alert:** Two large red buttons with the word "Alert" in white text, one on the left and one on the right of the Color section.
- Empty Box:** A large empty white rectangular box at the top center of the panel.

Task Parameters and Test Conditions

- Speech Task:
 - Duration: 50-60 minutes (340 stimuli)
 - Speech presented free field (60 dBA)
 - Mixed with a cafeteria babble
 - 4 SNRs- Participants did an “easy” and “hard” SNR. Specific SNR’s varied b/w groups (G1, G2)
 - Young NH: G1: Quiet & -4; G2: -2 & -6 dB SNRs
 - Older HI: G1: +2 & -2; G2: 0 & -4 dB SNRs
- Visual “Alerts” occur on 30% of trials
 - Random occurrence but distributed evenly
 - half during the first 170 trials and half during the 2nd 170 trials

Subjective Measures of Effort and Fatigue

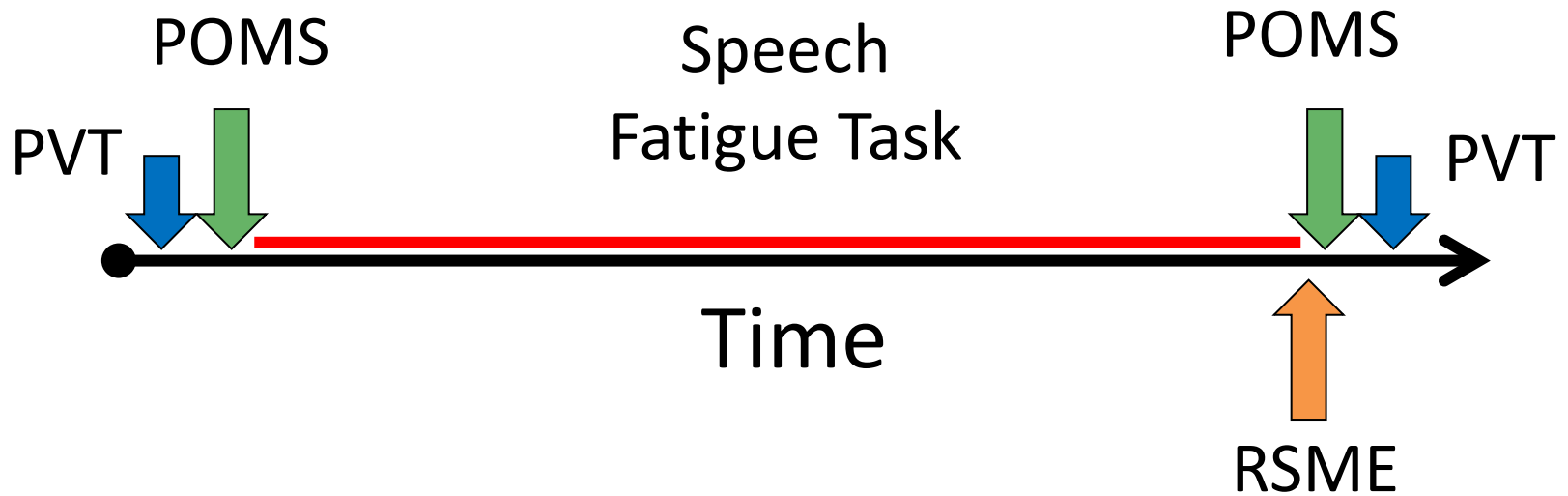
- Rating Scale of Mental Effort (RSME; Zijlstra, 1993)
 - Visual analogue scale, rate effort from “absolutely no effort” to > “Extreme effort”
 - Numeric range of 0-150
 - S’s rate “...effort it took you to finish the task.”
- Fatigue and vigor subscales of the Profile of Mood States (POMS; McNair, et al., 1971)
 - 15 items, describes “how you feel RIGHT NOW.”

Behavioral Measure of Fatigue

- Psychomotor Vigilance Task (PVT; Dinges & Powell, 1985) to assess sustained attention
 - Simple 10 minute visual vigilance task sensitive to fatigue related changes in attention
 - Completed before 1st POMS and after 2nd POMS
 - Fatigue quantified as a “decrement” in response times to visual marker (ability to maintain attention)



Study Procedures



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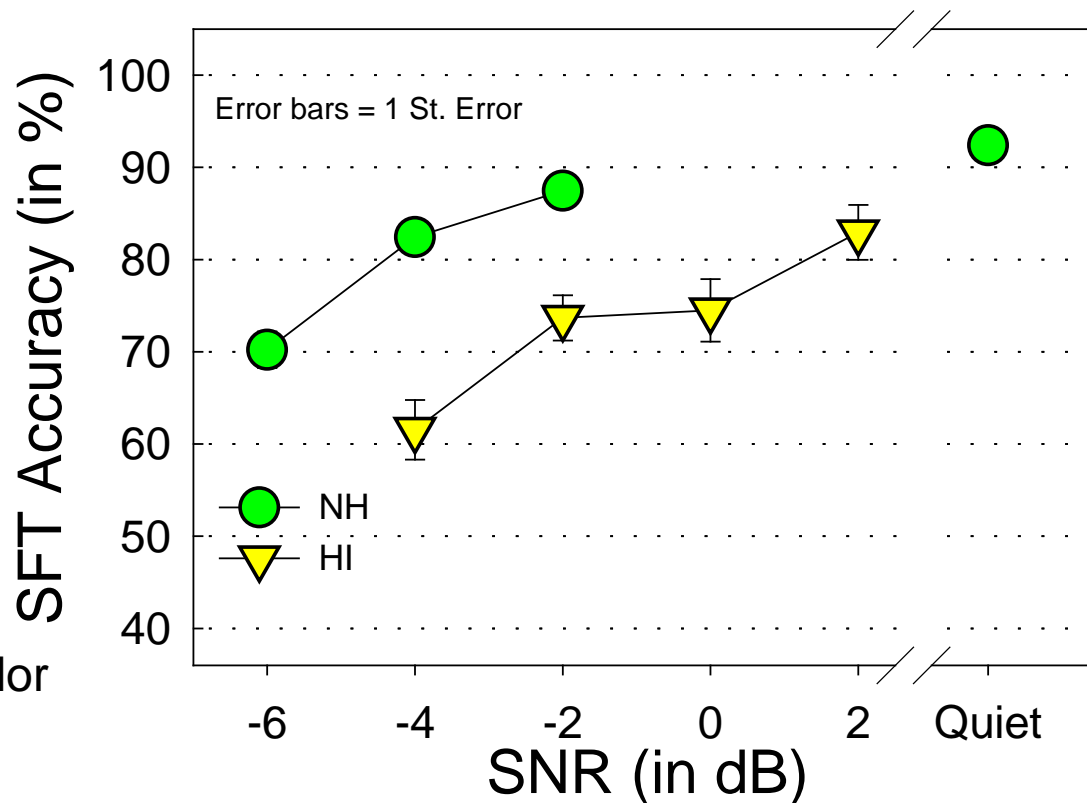


Results

Does task difficulty or HL
modulate fatigue?



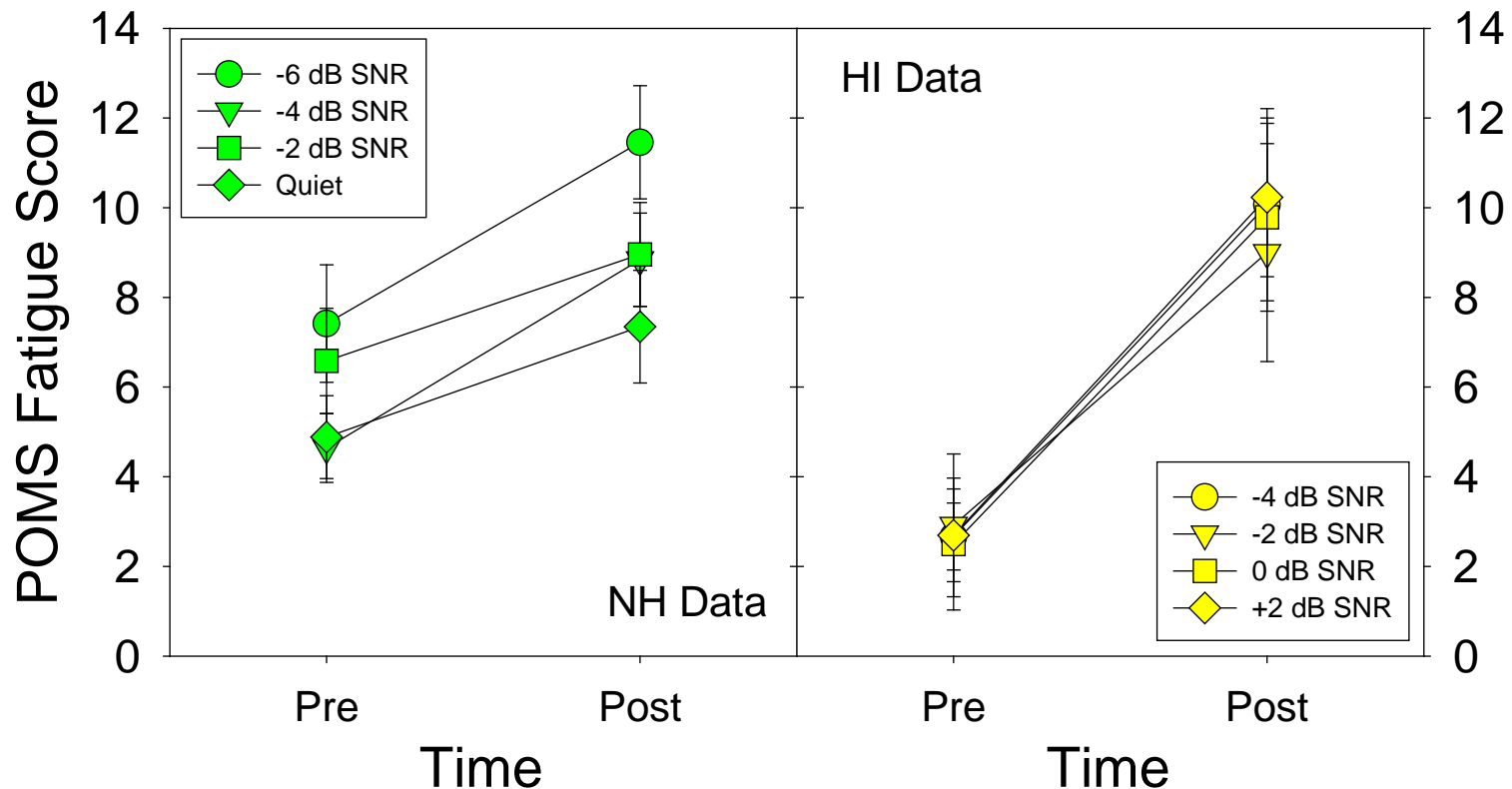
Does task difficulty or HL modulate fatigue? *Performance effects*



e.g., What color was Charlie?

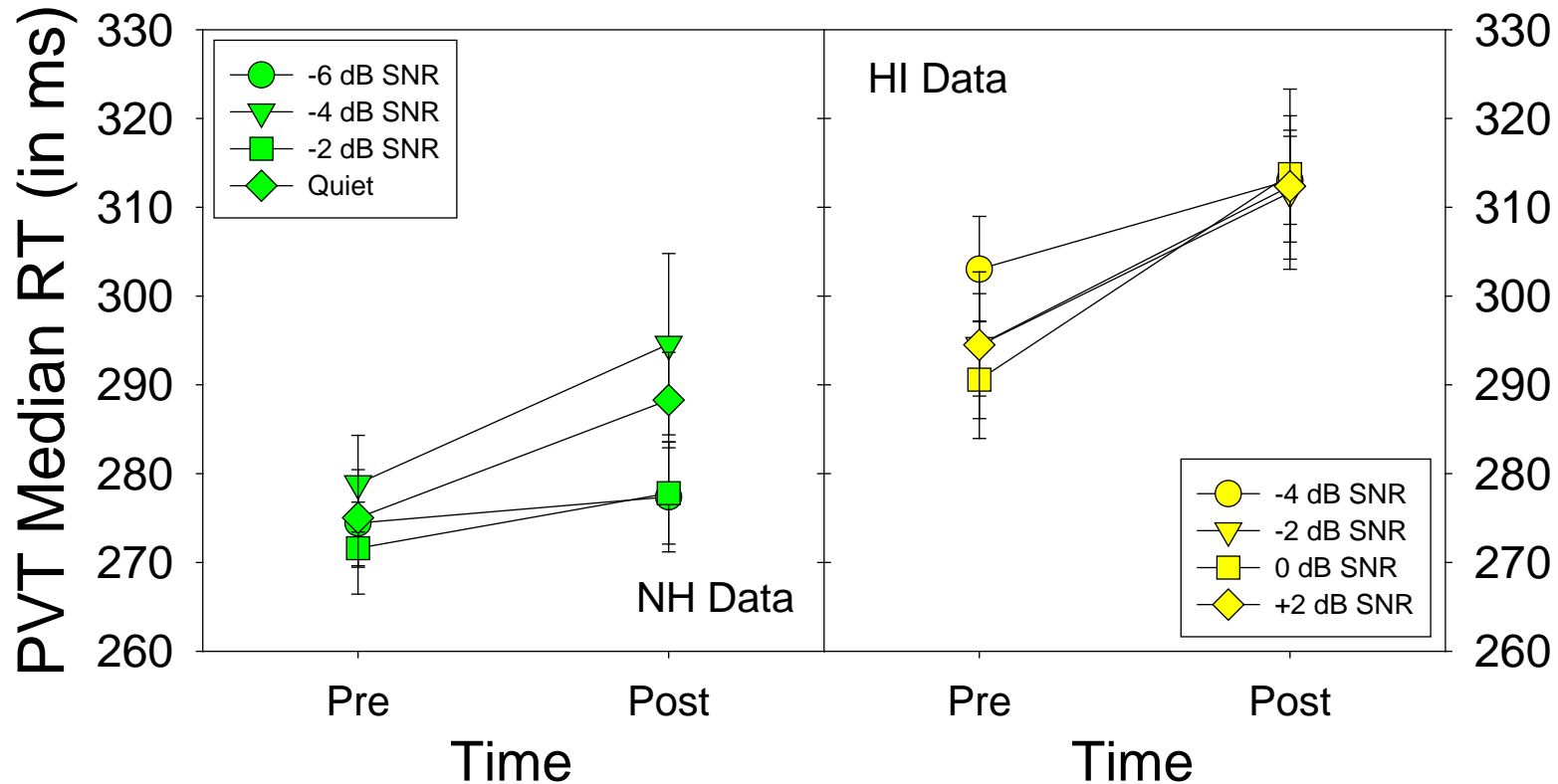
- Monotonic changes in performance with SNR for NH and HI groups

Does task difficulty or HL modulate fatigue? *Subjective fatigue*



- Task is fatiguing for both groups
 - More so for older HI group ($p < 0.05$)
- But unaffected by task difficulty (SNR)
 - And no SNR x time/group interactions (all $p > 0.05$)

Does task difficulty or HL modulate fatigue? *Behavioral fatigue*



- Significant effect of time and group (older HI are slower)
 - But no effect of SNR ($p > 0.05$)
 - And no interactions bw SNR, time or group (all $p > 0.05$)

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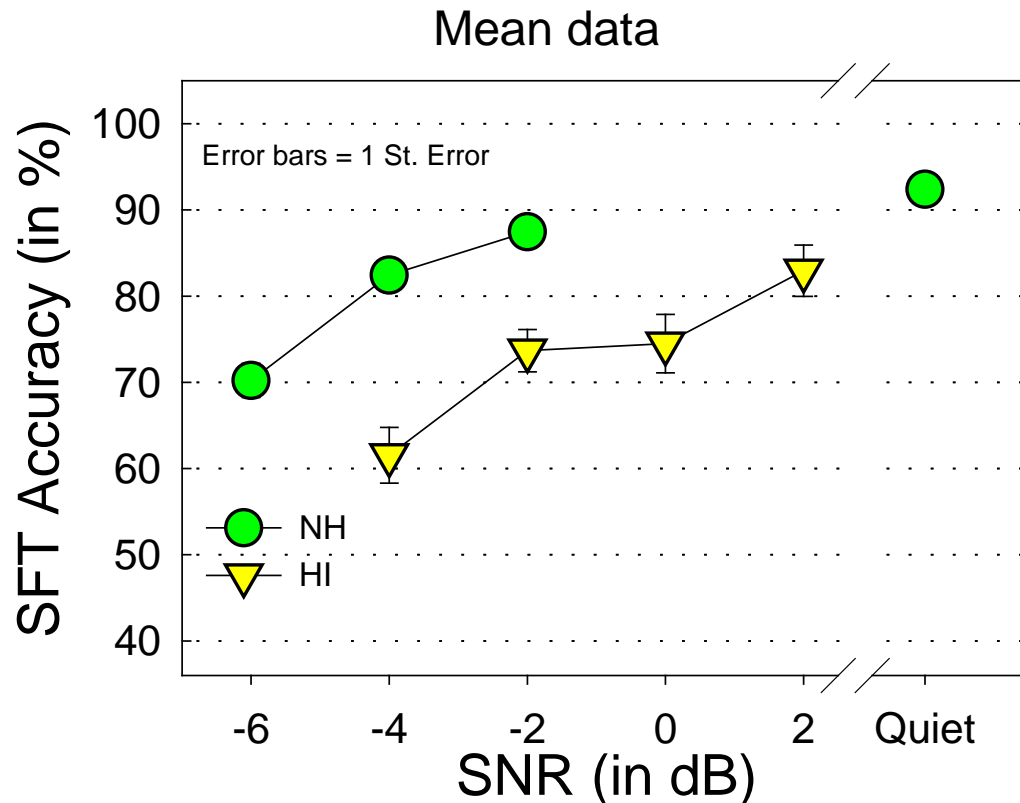


Results

Does task difficulty or HL
modulate effort?

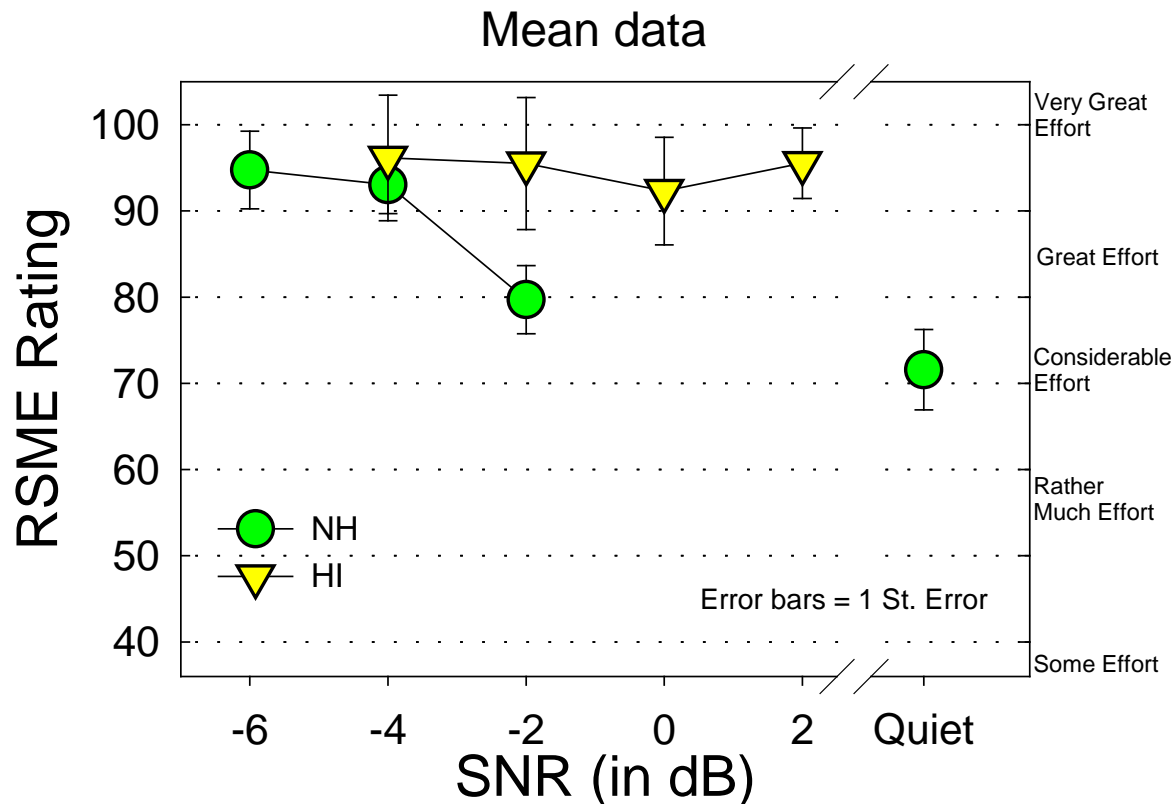


Associations Between Performance (SNR) and Mental Effort



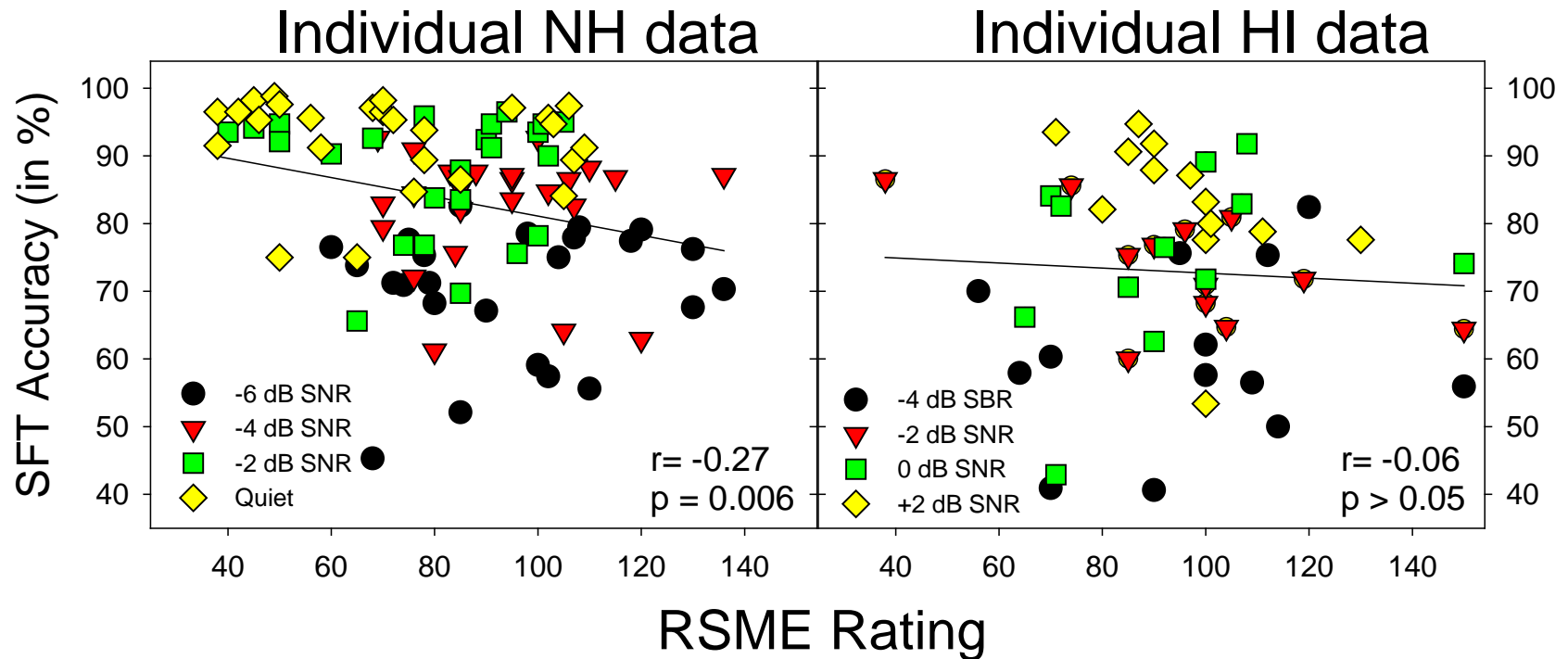
- Performance changes with SNR for NH and HI groups

Associations Between Performance (SNR) and Mental Effort



- But effort changes with SNR only for NH

Associations Between Performance (SNR) and Mental Effort



- Weak (NH) or no (HI) association between task difficulty (SNR) and perceived effort on the task

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Results

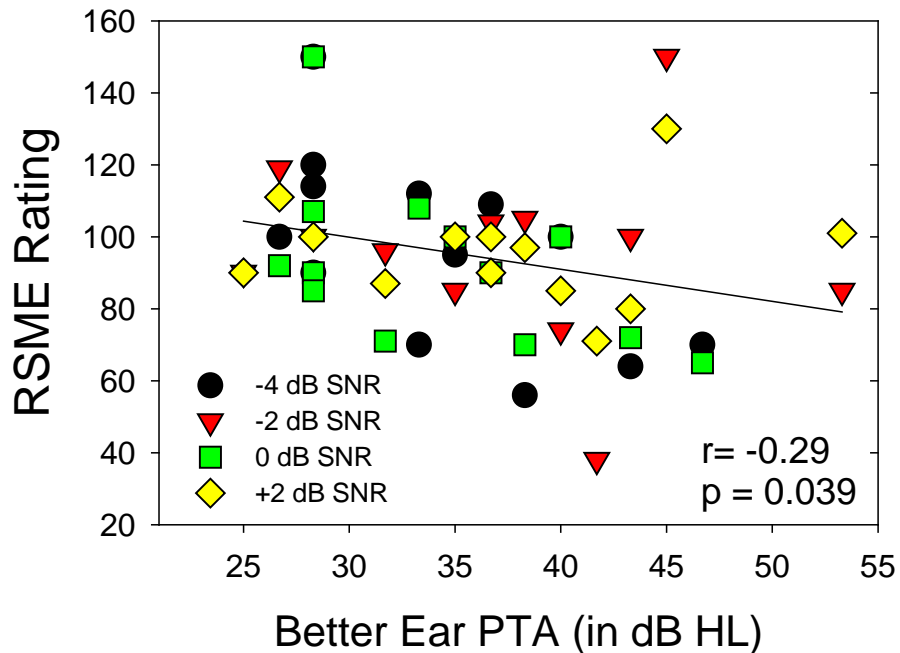
Associations between Degree of
Hearing Loss, Effort and Fatigue



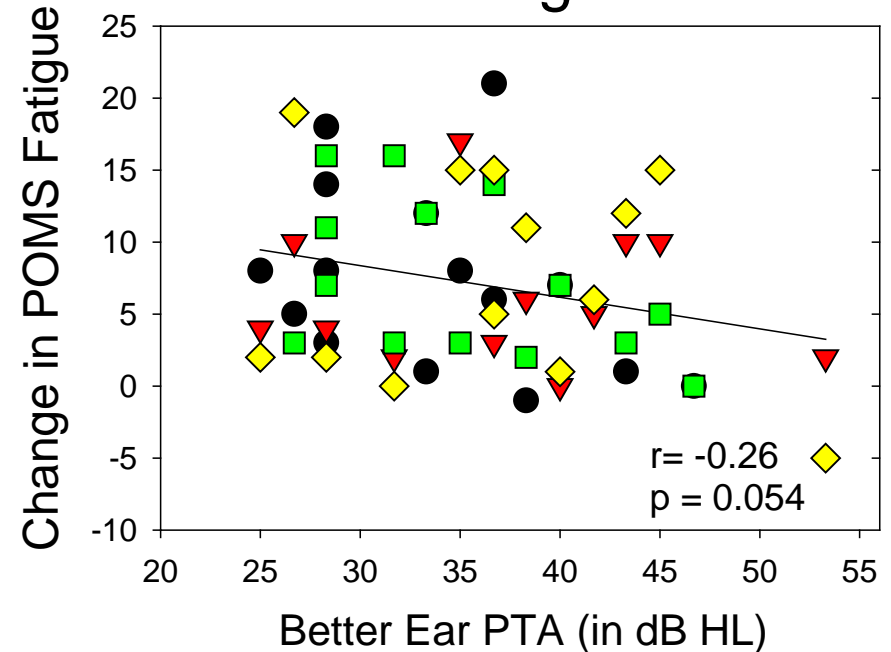
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Association Between 1) PTA & effort and 2) PTA & fatigability

PTA vs. RSME

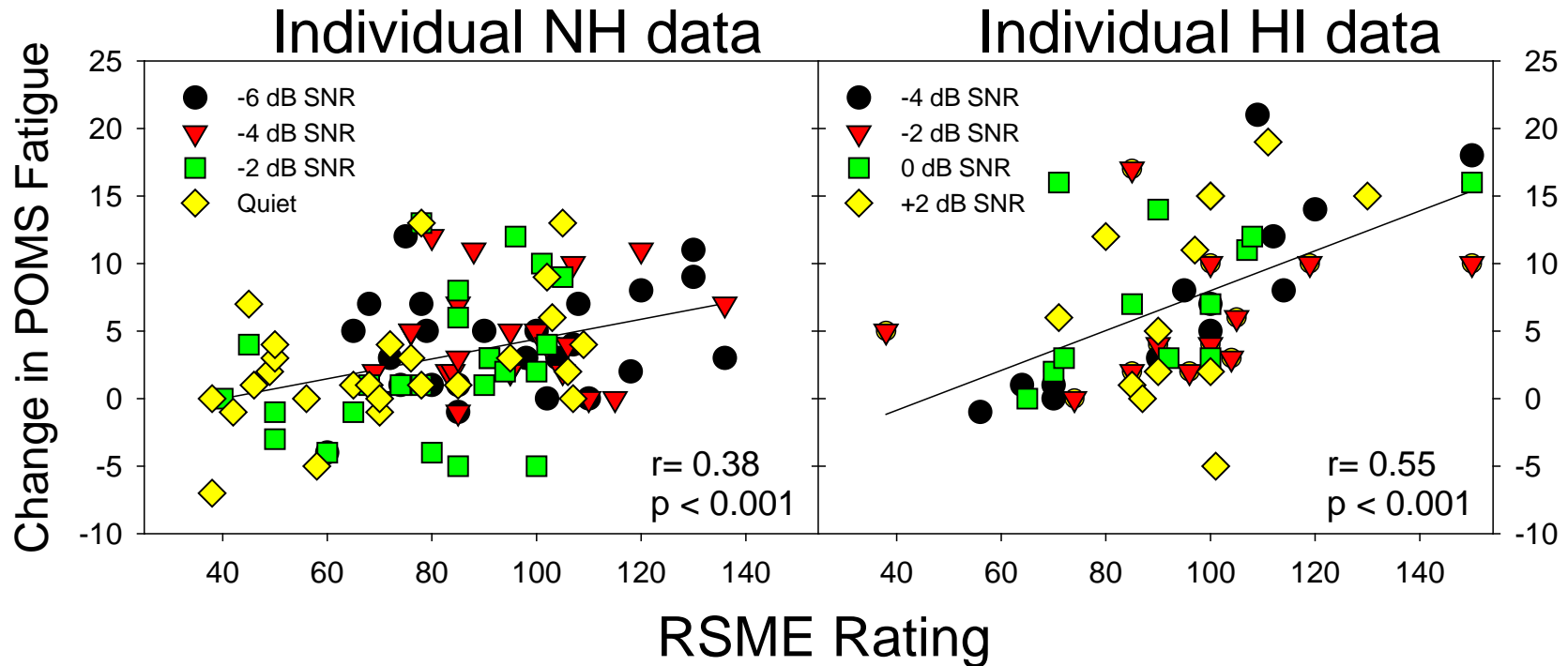


PTA vs. Change in POMs



- Weak association bw PTA and mental effort on task (RSME)
- No association bw PTA and change in POMS fatigue scores
- As PTA increases **fatigability and effort decrease**

Associations Between Fatigability and Mental Effort



- In contrast, strong association between fatigability and perceived effort on the task
 - Esp. in HI

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Summary/Conclusions

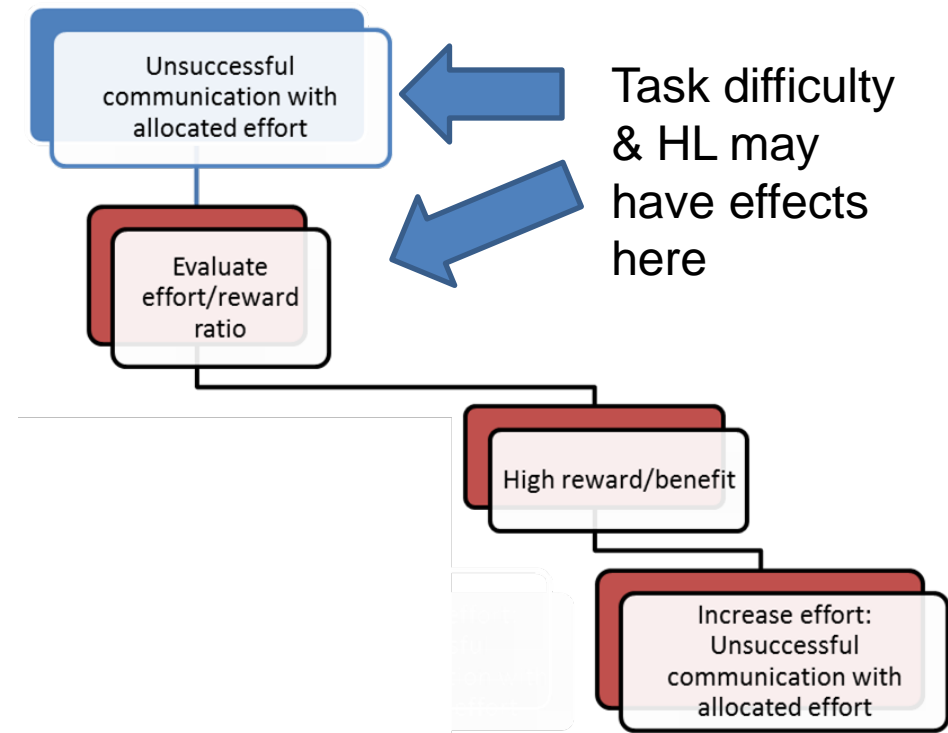


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Sustained speech processing can lead to subjective and behavioral fatigue

1. Does task difficulty or HL modulate speech-processing related fatigue?

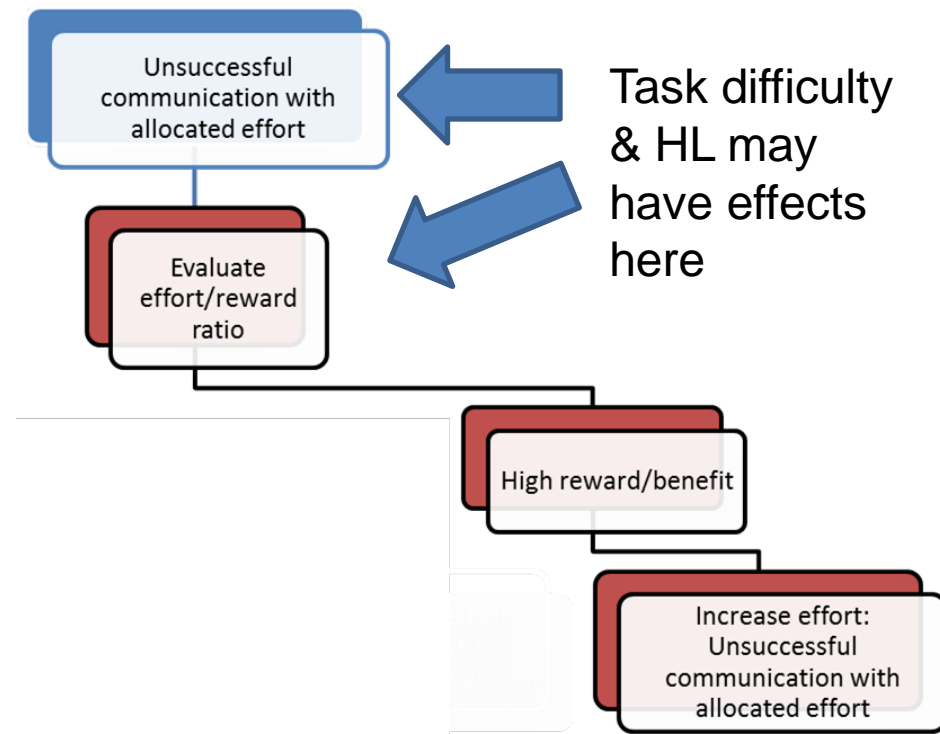
- **Task difficulty: No!**
- No relationship between SNR or individual performance on fatigability
- **Hearing Loss: Partly-**
- Subjective fatigue (POMS) was larger for older HI
 - No bw group difference in behavioral (PVT) fatigue



Sustained speech processing can lead to subjective and behavioral fatigue- Why?

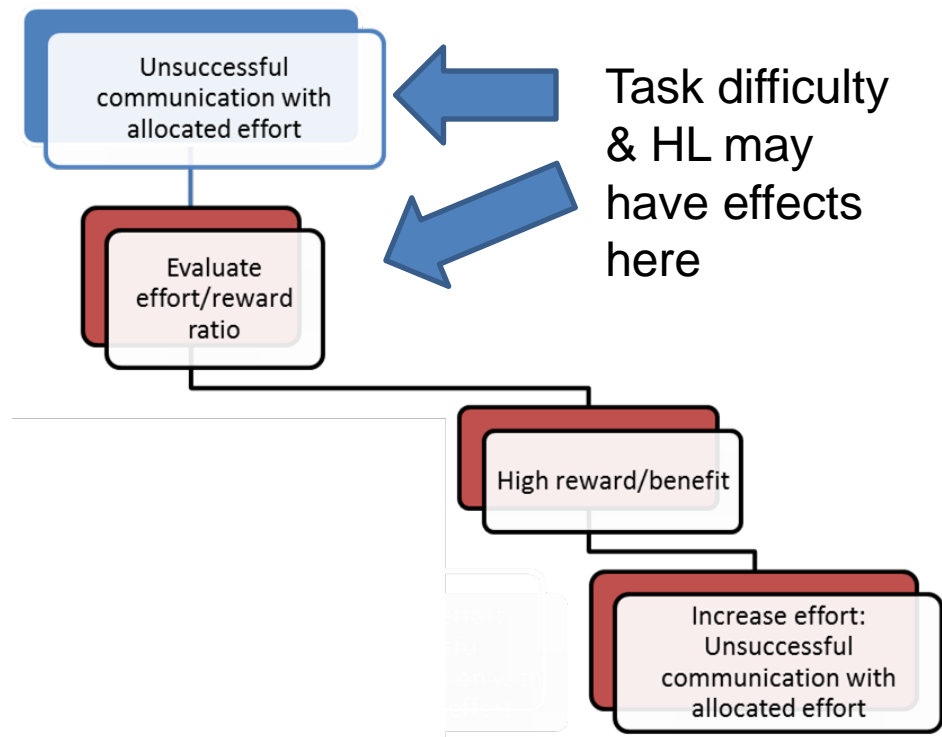
2. Does degree of HL modulate speech-processing related fatigue?

- **No:** PTA was not associated with variations in effort or fatigue
- Neither speech understanding ability OR degree of HL were strongly related to speech processing-related fatigue



Sustained speech processing can lead to subjective and behavioral fatigue- Why?

- Perceived effort (RSME rating) was the strongest predictor of speech processing-related fatigue
 - Esp. for our participants with hearing loss
 - **But perceived effort was NOT strongly related to SNR, performance, or degree of hearing loss**

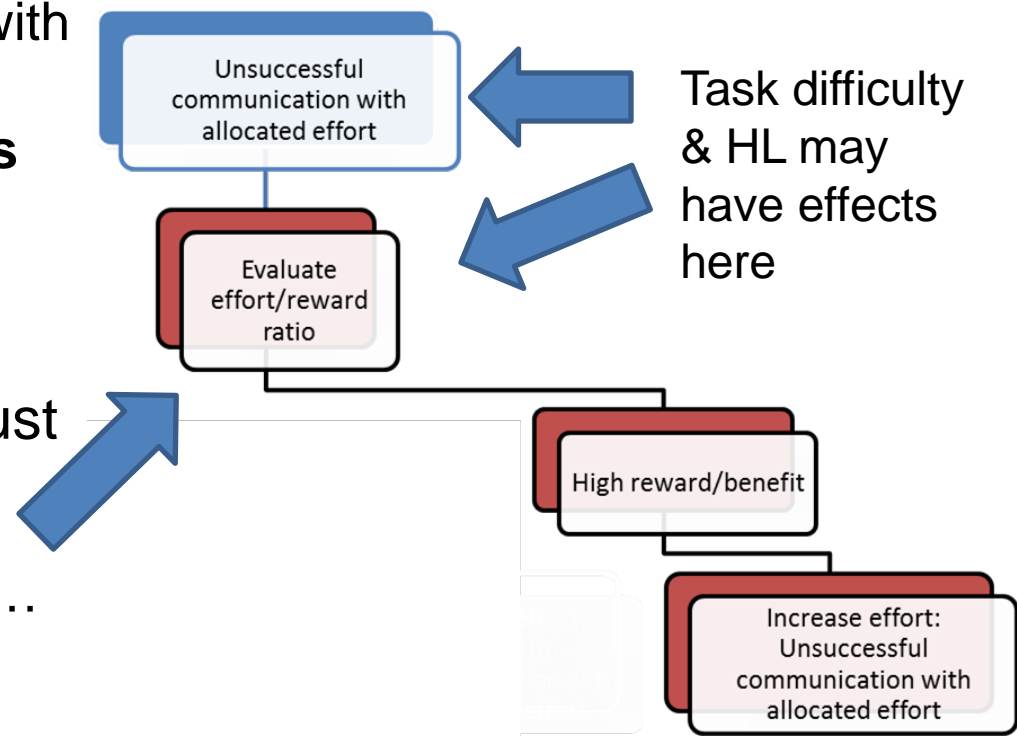


Sustained speech processing can lead to subjective and behavioral fatigue- Why?

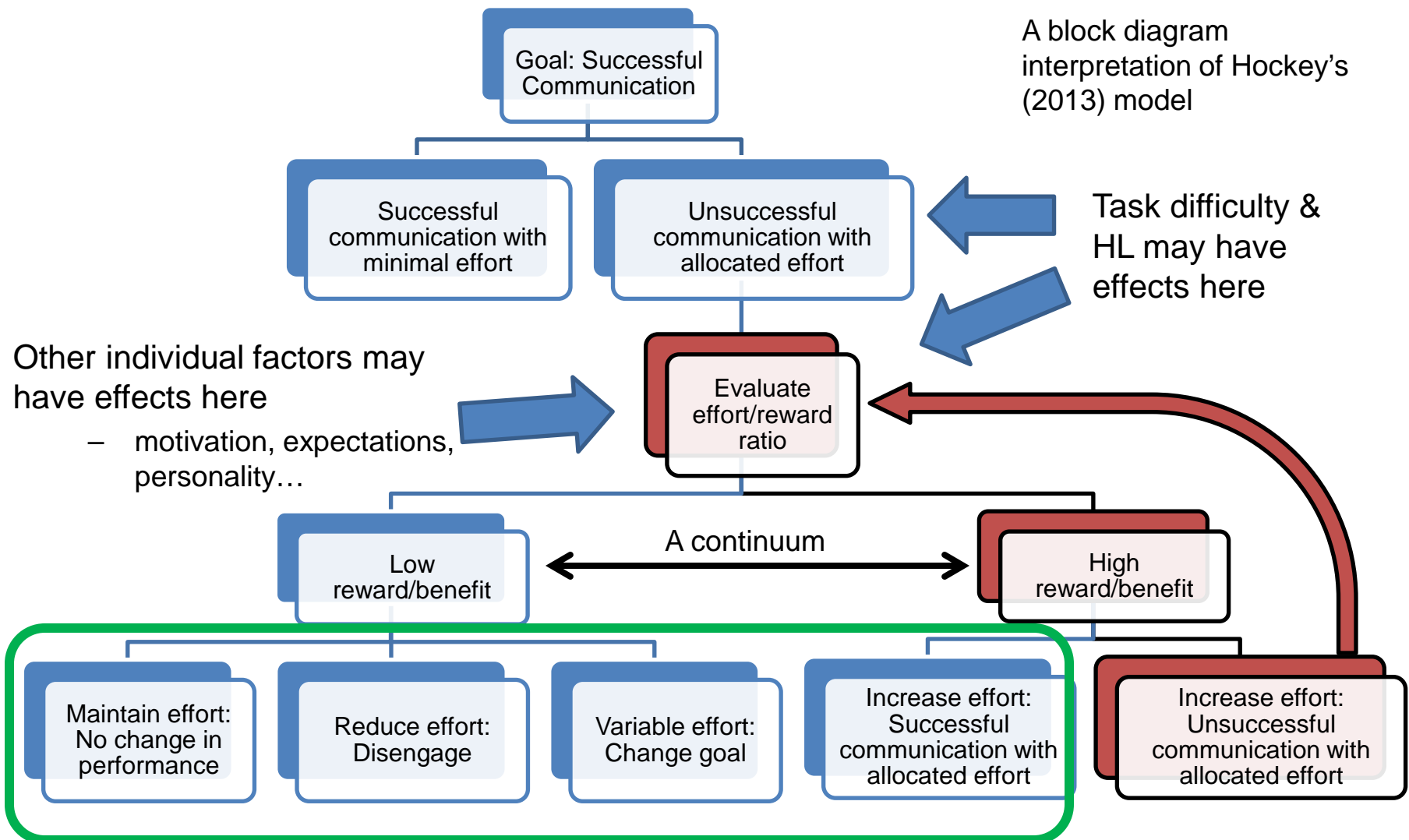
- Perceived effort (RSME rating) was the strongest predictor of speech processing-related fatigue

- Esp. for our participants with hearing loss
- **But perceived effort was NOT strongly related to SNR, performance, or degree of hearing loss**

- Other individual factors must play a dominant role
 - E.g., motivation, expectations, personality...



A motivational control theory of cognitive fatigue (Hockey, 2013)



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Future Research



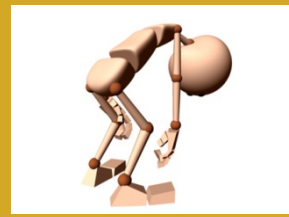
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There is a lot we don't know!

- Better understand the “fatigue experience” of persons with HL
 - Do our lab studies or generic questionnaires adequately capture the experiences of persons with HL?
- Develop/refine methods to quantify hearing loss- related stress, effort and fatigue
 - In laboratory and real world
- Characterize individual factors and physiologic mechanisms responsible for hearing loss- related fatigue
- More directly test and refine a model of hearing loss-related fatigue
 - Important for developing effective intervention strategies



Questions?



Interested in this area?
Potential Post-doc
position available.
See me for details!

