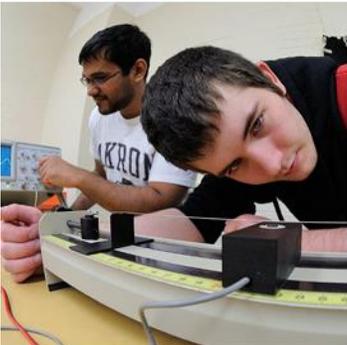


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# Cognitive and Pain Effects in Adult Chiari Malformation Type I



The University of Akron  
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# Outline of This Talk

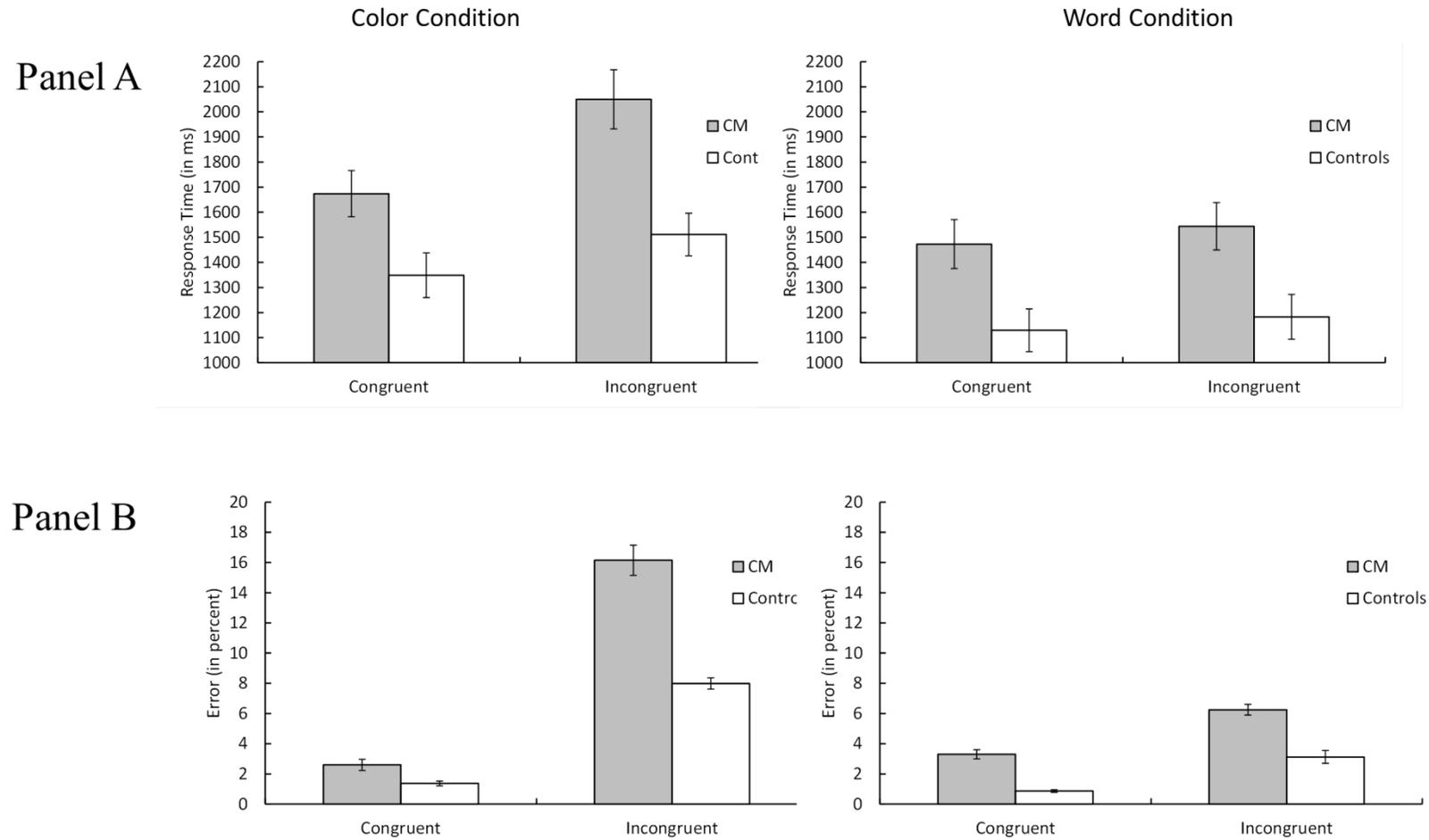
- **1. Evidence of Cognitive Effects in Chiari Malformation Type I**
- **2. Evidence that personality type can moderate the negative effect of pain on cognition**
- **3. Brain imaging evidence of cognitive and pain effects in Chiari Malformation Type I**

# Cognitive Effects in Chiari

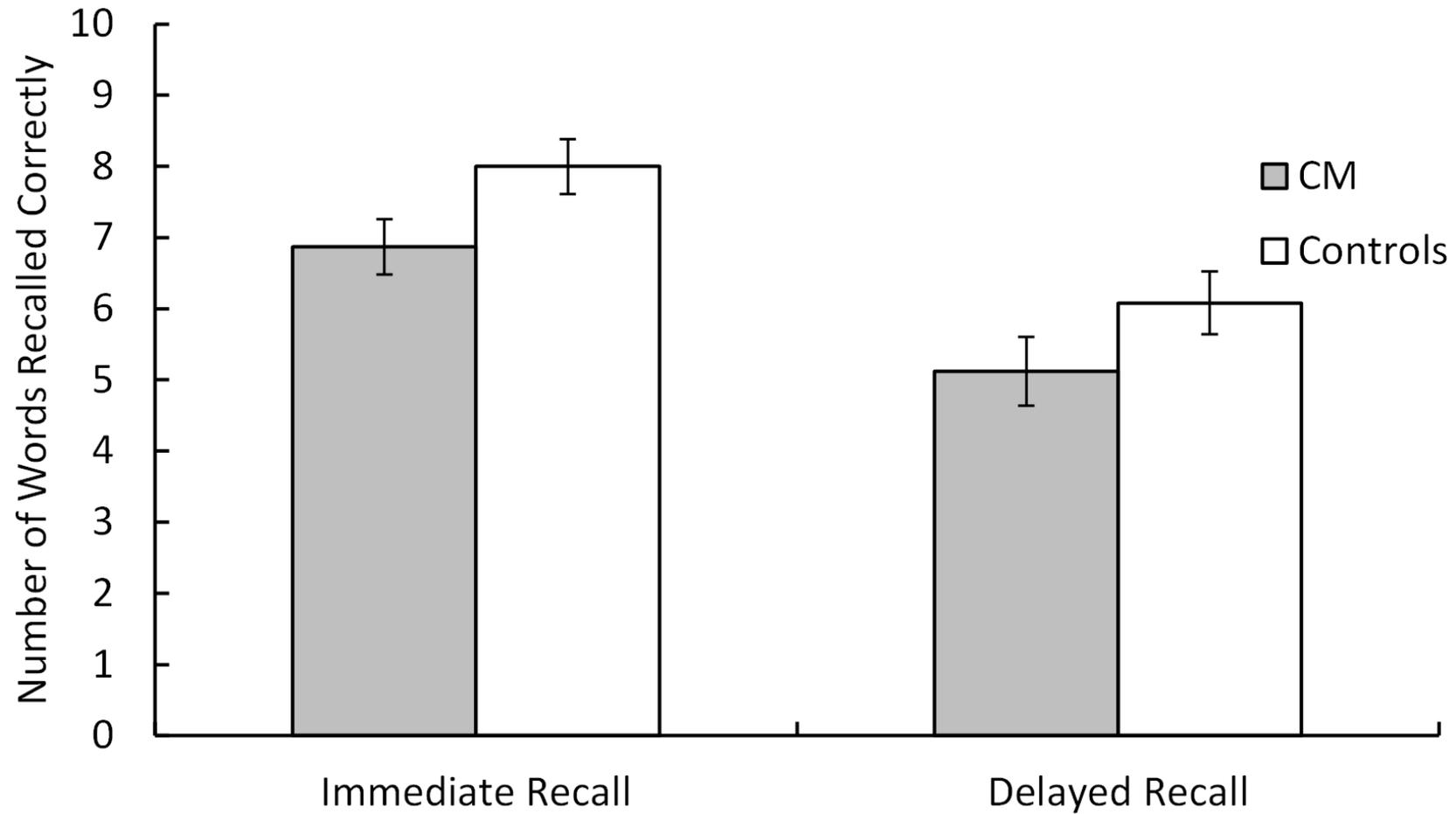
## Experimental Tasks

- Allen et al. (2014) tested 24 individuals diagnosed with CM1 and whom had undergone decompression surgery, as well as 24 age- and education-matched controls
- Data from immediate and delayed recall (RAVLT), response inhibition (Stroop), working memory (Ospan), and processing speed (automated digit-symbol substitution task) were collected
  - This was designed to assess whether adults diagnosed with CM1 exhibit cognitive deficits in executive function and memory effects

# Response Inhibition (Stroop) Results

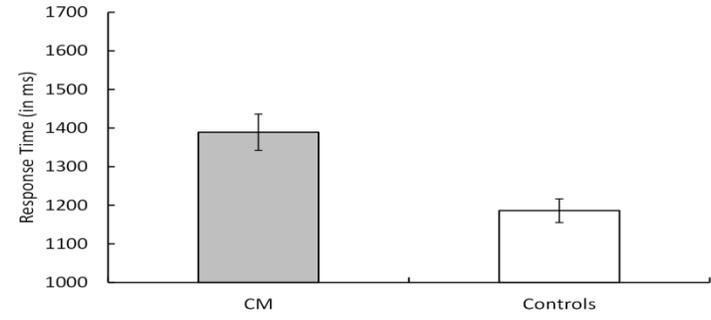


# Recall Results:

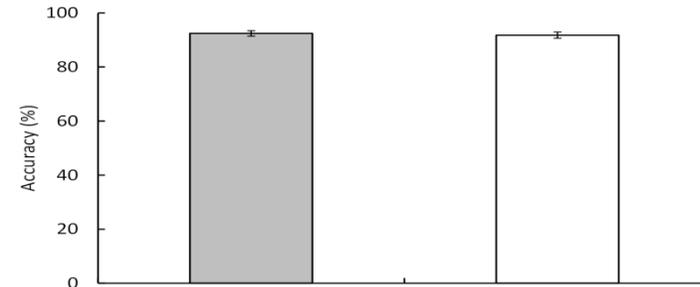


# Working memory (Ospan) Results:

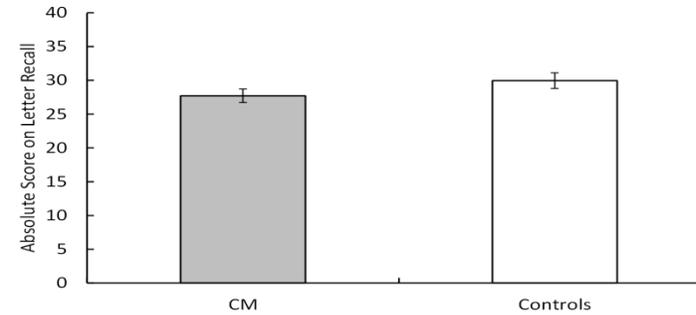
Panel A



Panel B

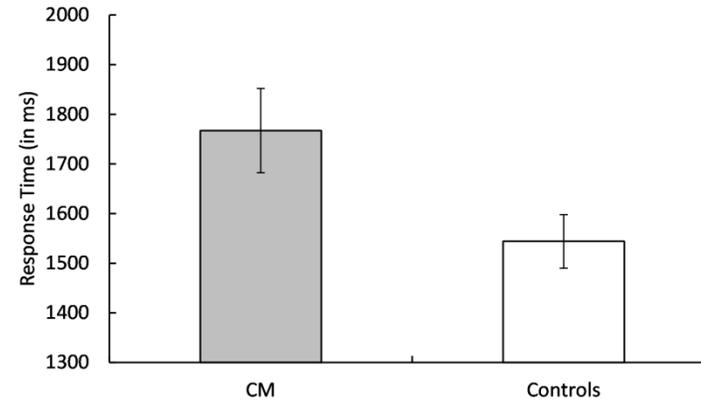


Panel C

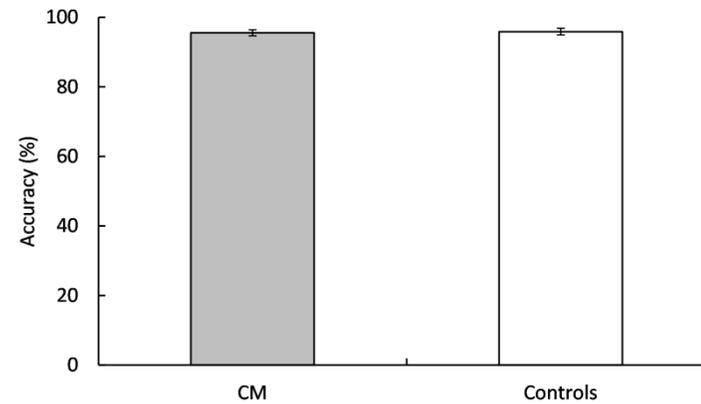


# Processing Speed (Automatized Digit/Symbol Substitution Task) Results:

Panel A:



Panel B:



# Cognitive Effects in Chiari Continued

## Allen et al. (2014) Summary:

- Of the five different cognitive tasks (immediate and delayed recall, Stroop interference, Ospan, and processing speed), the Stroop, working memory, and processing speed tasks showed poorer performance on the part of CM1 patients relative to controls
  - This suggests that CM1 results in executive dysfunction
  - However, when we statistically controlled for pain, just the Stroop (inhibitory control) effect remained significant
    - These results suggest that some, but not all, cognitive effects in CM1 are due to pain effects

# Cognitive Effects in Chiari Continued

## Episodic Memory Re-examined:

- In order to test whether CM1 patients show an immediate recall effect (because the Allen et al., 2014, data showed a trend), we (Allen et al., 2018) collected RAVLT (an immediate recall task) data on 638 Chiari patients from the Chiari 1000 Project and compared these data to a set of healthy controls (from other studies)
  - First, we assessed whether there were group differences in surgery status (decompressed vs. non-decompressed) from CM1 patients
    - there were no group differences between individuals who had been decompressed versus those that had not
  - Next, we compared recall in the CM1 group to age-matched controls
    - The CM1 group recalled significantly fewer words than did healthy controls  $M_{CM} = 5.96$  words,  $M_{Control} = 6.93$  words)
    - **These results confirm that CM1 individuals do show lower immediate recall than controls**

# Cognitive Effects in Chiari Continued

## Standardized Tasks:

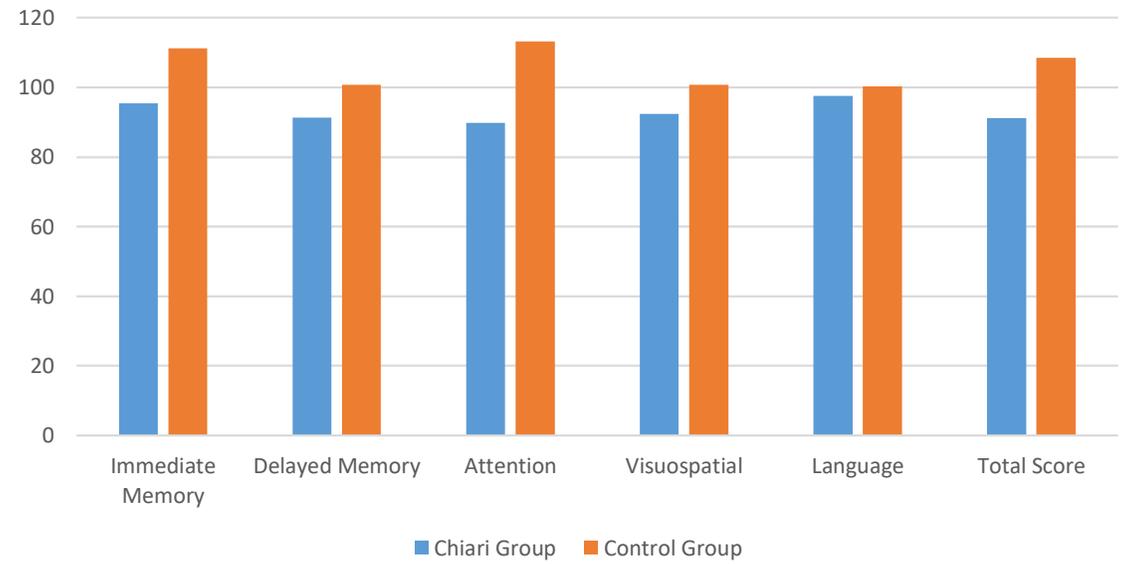
- While experimental tasks such as those used by Allen et al. (2014, 2018) allow precise tests of cognitive function, they are not normed/standardized
- A key issue is whether the cognitive deficits in experimental tasks are “clinically meaningful”
  - That is, do CM1 patients show cognitive performances that fall 1-1.5 standard deviations below age- and education-matched controls?

# Cognitive Effects in Chiari Continued

## Standardized Tasks:

- To test whether cognitive effects in CM1 are clinically meaningful, we (Houston et al., under review) report data from 18 CM1 patients (mean age = 34.5 years, mean years of education = 13.9 years) who were candidates for decompression surgery and 18 age- and education-matched controls (mean age = 37.3 years, mean years of education = 14.3 years) on the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS)
  - These two groups did not differ significantly in terms of age or years of education

RBANS Scores by Test Type



# Cognitive Effects in Chiari Continued

## RBANS Results:

- Total Scale Index scores:  $p < .01$  (Chiari group = 91.2, Controls = 108.5 (difference = 17.3),  $p < .01$ ).
- Immediate Memory: Chiari group = 94.5, Controls = 111.2 (difference = 16.7),  $p < .01$
- Attention: Chiari group = 89.8, Controls = 113.2 (difference = 23.4),  $p < .001$
- Visual Construction: Chiari group = 92.4, Controls = 100.7 (difference = 8.3), **not significantly different**
- Language: Chiari group = 97.6, Controls = 103.0 (difference = 5.4), **not significantly different**
- Delayed Memory: Chiari group = 91.3, Controls = 100.8 (difference = 16.6),  $p < .05$

# Cognitive Effects in Chiari Continued

## RBANS Results:

- The Attention (1.6 standard scores) and Total Index Score (1.1 standard scores) show meaningful performance decrements for Chiari patients
  - Standard scores of greater than 1.0 are clinically meaningful—so age- and education-matched controls scored meaningfully higher than CM1 patients in these two areas
- With the exception of the Language domain and Visual Construction domains, all other domains showed deficits in the Chiari group
  - Attention and the Total Index Score showed meaningful deficits (1 standard deviation, or higher) for the CM1 group

# Reflection Moderates the Negative Effect of Pain on Memory in Some CM1 Patients

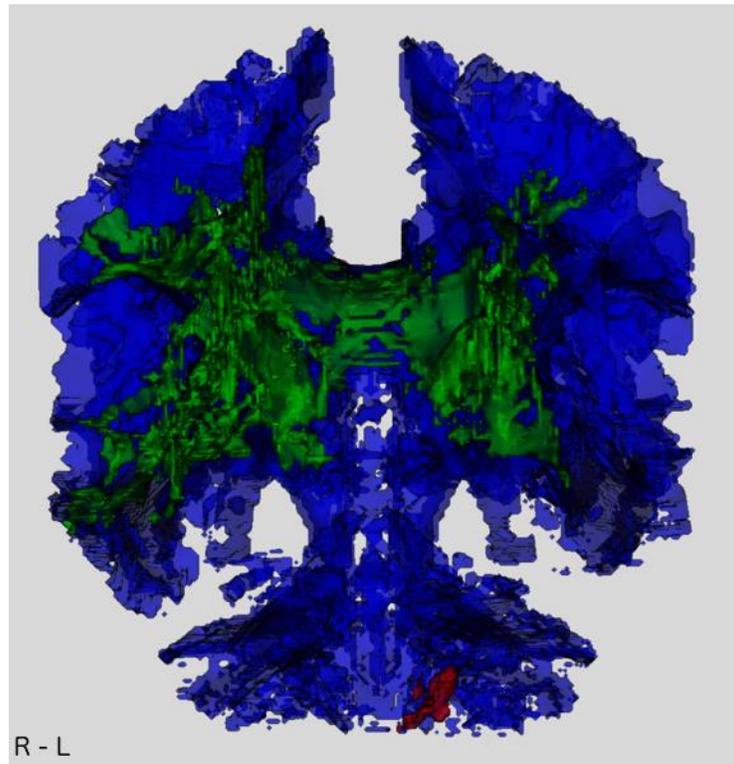
- Reflection is a personality characteristic that tests for positive self-focused attention (Trapnell & Campbell, 1999). We (Allen et al., 2018) examined the Reflection, self-reported pain, and delayed recall data from 638 individuals from the Chiari 1000 study (341 decompressed and 297 non-decompressed CM1 patients).
- In general, as pain levels increased, delayed recall performance decreased.
  - However, for the non-decompressed CM1 patients (but not for decompressed individuals), **higher levels of reflection at lower pain levels were associated with better memory performance than non-decompressed individuals with lower pain levels and lower levels of Reflection**
  - When there were higher levels of self-reported pain, Reflection did not help individuals better inhibit the distracting effect of pain
- This raises the possibility that specific interventions designed to train CM1 patients to inhibit the distracting effects of pain may improve cognitive performance
  - **Mindfulness interventions such as Acceptance and Commitment Therapy (ACT) have shown effectiveness in helping low back pain patients inhibit pain effects**

# Brain Imaging of Cognitive and Pain Effects in Chiari

## Diffusion Tensor Imaging (DTI) and CM1:

- Structural MRI can provide an index of the “white-matter” integrity of fiber tracts in the brain. This provides a test of the communication pathways in the brain.
  - DTI-based fractional anisotropy (FA) is the most common measure of the intactness of communication pathways in the brain
- CM1 patients (n = 18) showed higher FA values and lower RD values than age- and education-matched controls (n = 18)
- FA showed a significant negative correlation with RBANS Attention scores and a positive correlation with SF-MPQ-2 (pain) total scores for the full group (N = 36)
- RD showed a significant negative correlation with RBANS Total scores for just the Chiari group (but not the control group)

# Coronal Section Showing DTI/FA Results (Green ROI correlated with pain, Red ROI correlated with RBANS Attention Scores)



# Brain Imaging of Cognitive and Pain Effects in Chiari Continued:

## Diffusion Tensor Imaging (DTI) and CM1:

- Typically DTI FA decreases with losses white-matter integrity.
  - However, in cases involving inflammation, FA frequently increases—it appears that FA increases in Chiari for this reason
- To summarize, as RBANS scores decrease, FA increases in part of the cerebellum (possibility due to inflammation in Chiari). Also, as pain levels increase, FA increases in the Cingulum (possibility due to “dendritic sprouting”)
- RD showed a significant negative correlation with RBANS Total scores for just the Chiari group (but not the control group)

# Conclusion

- **1. There are executive function and memory effects in Chiari Malformation Type I**
- **2. Increased reflection (associated with better self-focused attention) appears to help CM1 individuals inhibit the negative effect of pain on memory**
- **3. Brain imaging (DTI FA values) shows evidence of differences in white matter integrity in the cerebellum (associated with lower Attention scores) in Chiari patients relative to controls**