

### SUMMARY

#### Redundancy in the measurement of thinking styles

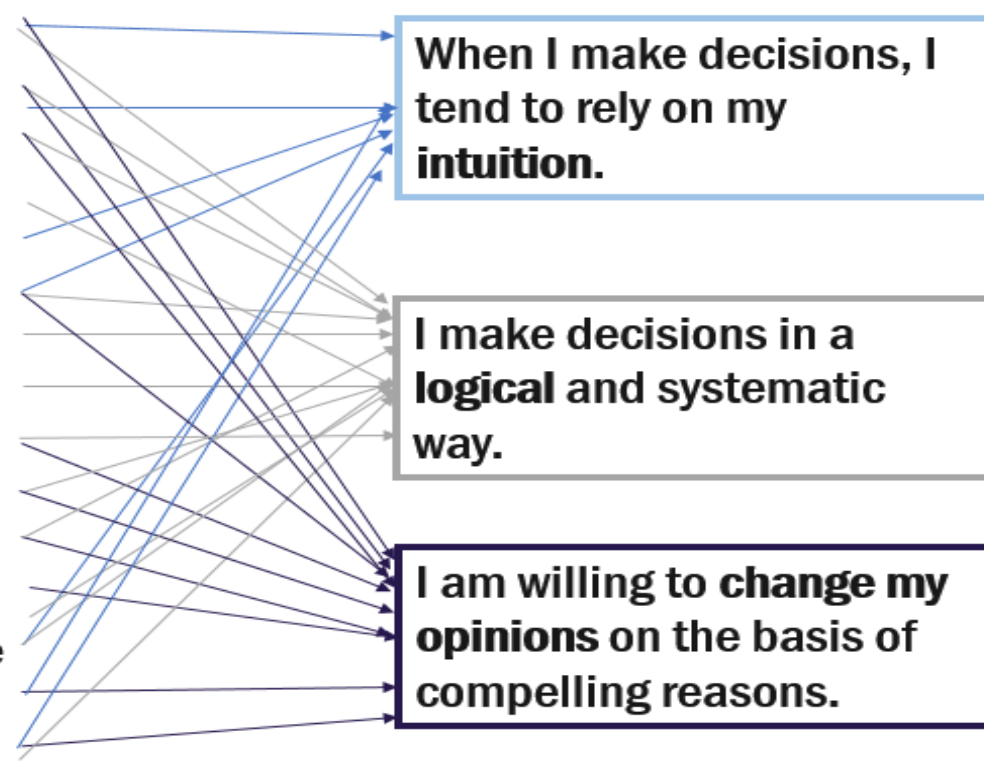
- There are a wide variety of dual-process theories and, subsequently, **more than 20 intuitive-analytic thinking style measures are being used** by researchers.
- Although many of these scales share a clear **conceptual and theoretical overlap**, several of them are informed by different underlying theoretical perspectives.

#### Creating parsimony in the thinking styles literature, by condensing 15 existing (popular) measures into one comprehensive thinking style measure

- Across eight preregistered online studies ( $N=4014$ ) we systematically narrow down 265 items from 15 scales into a **24-item Comprehensive Thinking Style Questionnaire (CTSQ)**.
- These studies reveal four correlated underlying traits that distinguish intuitive-analytic thinkers: **Actively Open-minded Thinking, Close-minded Thinking, Preference for Intuitive Thinking, and Preference for Effortful Thinking**.
- These subscales are differentially predictive of epistemically suspect beliefs and judgments shown to relate to intuitive-analytic thinking style.
- **Our new measure generally outperforms the Cognitive Reflection Test**, a popular behavioral measure of thinking styles, in predicting misperceptions about COVID-19, the ability to discern between vaccination-related true and false news, and both COVID-19 vaccination intentions and attitudes.

### RESULTS – SCALE DEVELOPMENT

- 1 Actively Open-Minded Thinking Scale
- 2 Actively Open-Minded Thinking Scale - 10
- 3 Comprehensive Intellectual Humility Scale
- 4 Epistemic Curiosity Scale
- 5 Faith in Intuition Scale
- 6 General Decision-Making Style Scale
- 7 Importance of Rationality Scale
- 8 Intolerance of Ambiguity Scale
- 9 Need for Closure Scale
- 10 Need for Cognition
- 11 Need for Evidence Scale
- 12 Need to Evaluate Scale
- 13 Preference for Intuition and Deliberation Scale
- 14 Resistance to Change Scale
- 15 Self-Righteousness Scale



MODEL	$\chi^2_m$	df <sub>m</sub>	$\Delta\chi^2$	$\Delta df$	$\chi_{cv}$	RMSEA [90% CI]	CFI	$\Delta CFI$	TLI	SRMR
1-factor model of general CTSQ	3139.20	252.00	-	-	-	.167 [0.161-.172]	.446	-	.393	.156
Uncorrelated 4-factor (AOT, CMT, PIT, PET)	747.03	252.00	2392.17	0	0	.069 [0.063-.075]	.905	.459	.896	.161
Correlated 4-Factor with Higher Order Factor*	580.93	249.00	166.10	166.10	7.83	.057 [0.051-.063]	.936	.031	.929	.065
<b>Correlated 4-factor model (AOT, CMT, PIT, PET)</b>	<b>568.90</b>	<b>246.00</b>	<b>12.03</b>	<b>3</b>	<b>7.83</b>	<b>.056 [0.050-.062]</b>	<b>.938</b>	<b>.002</b>	<b>.930</b>	<b>.057</b>

Criteria: Changes in chi-square > critical value; changes in the CFI model fit > .002 \*CTSQ higher-order factor was fixed at 1 in Model 3 to allow for model convergence

### RESULTS – PREDICTIVE VALIDITY

REGRESSION WEIGHTS  
\*\* $p < .01$ , \* $p < .05$

MEASURE	ACTIVELY OPEN-MINDED THINKING	CLOSE-MINDED THINKING	PREFERENCE FOR INTUITIVE THINKING	PREFERENCE FOR EFFORTFUL THINKING
Religious Belief	<b>-0.47**</b>	0.17**	0.02	-0.06
Paranormal Belief	<b>-0.25**</b>	-0.10*	<b>0.26**</b>	-0.02
Conspiratorial Belief	<b>-0.36**</b>	0.06	0.18**	-0.09
Bullshit Receptivity	<b>-0.25**</b>	0.02	0.16**	< 0.001
Empathizing Quotient	-0.06	0.04	0.18**	<b>0.38**</b>
Subjective Happiness	-0.20**	0.15**	0.06	<b>0.39**</b>
Moral Dilemma	-0.13*	<b>0.20**</b>	0.14**	0.07
Disgust	0.01	0.10	<b>0.17**</b>	0.10

### STUDY 7

### a. COVID-19 OUTCOMES: CTSQ vs CRT

MEASURE	VACCINE ATTITUDES		VACCINE INTENTIONS		MISPERCEPTIONS		NEWS DISCERNMENT	
	Canada	U.S.A	Canada	U.S.A	Canada	U.S.A	Canada	U.S.A
Cognitive Reflection Test	.04	.08*	.02	.08*	-.05	-.05	.07*	.16**
<b>Actively Open-minded Thinking</b>	<b>.19**</b>	<b>.08*</b>	<b>.11**</b>	<b>.07</b>	<b>-.34**</b>	<b>-.39**</b>	<b>.25**</b>	<b>.25**</b>
Close-Minded Thinking	-.04	-.09**	-.05	-.10**	.18**	.20**	-.06*	-.09**
Preference for Intuitive Thinking	-.14**	-.13**	-.10**	-.10**	.04	.10**	-.11**	-.07*
Preference for Effortful Thinking	-.02	.00	-.05	-.05	-.17**	-.10**	.14**	.15**



MEASURE	VACCINE ATTITUDES			VACCINE INTENTIONS			MISPERCEPTIONS			NEWS DISCERNMENT		
	Lib	Mod	Cons	Lib	Mod	Cons	Lib	Mod	Cons	Lib	Mod	Cons
Cognitive Reflection Test	.18**	.07	.10	.15**	.00	.03	-.29**	-.19**	-.23**	.29**	.15**	.20**
<b>Actively Open-minded Thinking</b>	<b>.34**</b>	<b>.17**</b>	<b>.17**</b>	<b>.20**</b>	.07	.11	<b>-.59**</b>	<b>-.45**</b>	<b>-.40**</b>	<b>.42**</b>	<b>.41**</b>	<b>.33**</b>
Close-Minded Thinking	-.14**	-.10	-.08	-.08	-.04	-.11	.39**	.31**	.32**	-.22**	-.18**	-.25**
Preference for Intuitive Thinking	-.25**	-.20**	-.26**	-.15**	-.10	-.18**	.33**	.24**	.31**	-.32**	-.23**	-.31**
Preference for Effortful Thinking	.19**	.04	.06	.09	.01	-.03	-.51**	-.40**	-.24**	.36**	.27**	.28**



MEASURE	VACCINE ATTITUDES			VACCINE INTENTIONS			MISPERCEPTIONS			NEWS DISCERNMENT		
	Lib	Mod	Cons	Lib	Mod	Cons	Lib	Mod	Cons	Lib	Mod	Cons
Cognitive Reflection Test	.25**	.16**	.02	.31**	.09	-.05	-.40**	-.35**	-.17**	.47**	.32**	.20**
<b>Actively Open-minded Thinking</b>	<b>.24**</b>	<b>.13*</b>	<b>.07</b>	<b>.23**</b>	-.01	.03	<b>-.66**</b>	<b>-.46**</b>	<b>-.38**</b>	<b>.55**</b>	<b>.36**</b>	<b>.25**</b>
Close-Minded Thinking	-.13*	-.08	-.14**	-.11*	-.03	-.13**	.29**	.26**	.36**	-.25**	-.22**	-.18**
Preference for Intuitive Thinking	-.22**	-.22**	-.06	-.22**	-.05	-.04	.35**	.22**	.29**	-.29**	-.20**	-.20**
Preference for Effortful Thinking	.18**	.06	.06	.14**	.00	-.03	-.49**	-.37**	-.30**	.45**	.32**	.28**

### OVERVIEW OF STUDIES

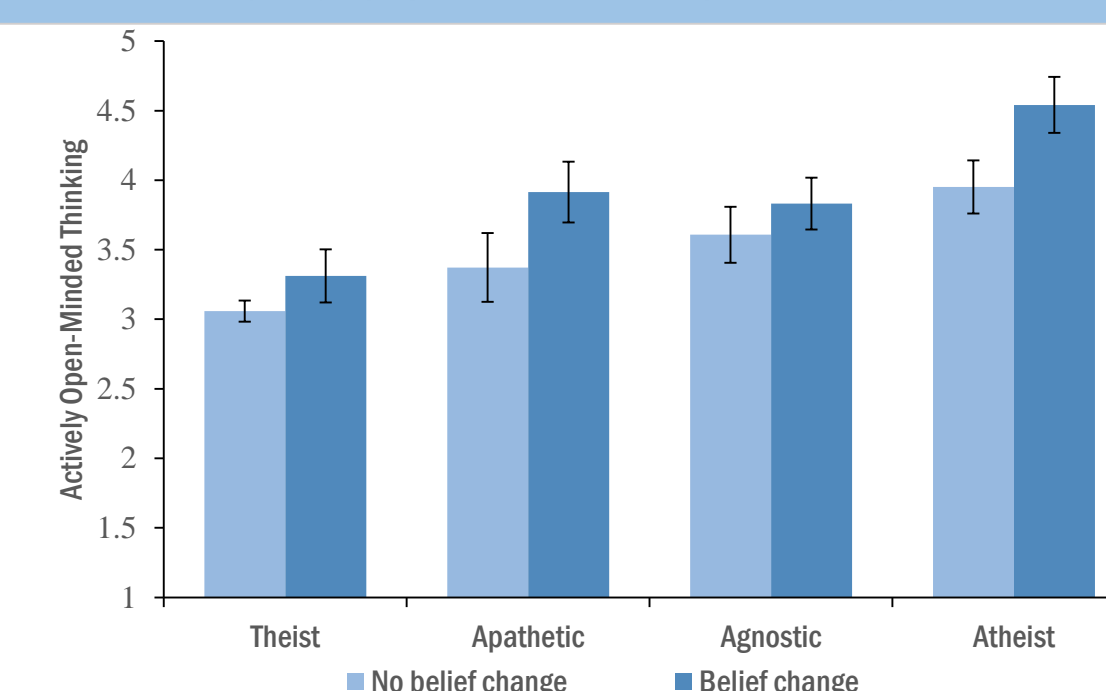
STUDY	NUMBER OF ITEMS	SUBJECT POOL	SAMPLE (U.S.)	PURPOSE / RESULTS
1	265	MTurk	774	Narrowed down 265 items to 50 items based on +/- .21 correlation with Cognitive Reflection Test Found 3 factors: Actively Open-minded Thinking, Preference for Intuitive Thinking, Preference for Effortful Thinking
2	50	MTurk	204	Found 4 factors: Actively Open-minded Thinking, Close-Minded Thinking, Preference for Intuitive Thinking, Preference for Effortful Thinking
3	26	Prolific	262	Improved the Actively Open-minded Thinking subscale by developing new items
4	34	Prolific	271	Found separate subscales for Actively Open-minded Thinking and Close-Minded Thinking
5	42	Prolific	199	Found that a four-factor correlated structure was the best fit for the new measure (CTSQ)
6	24	Prolific	260	Demonstrated the predictive validity of the CTSQ on seven outcomes related to intuitive-analytic thinking styles
7	24	Prolific	413	Demonstrated that the CTSQ has stronger predictive validity than the CRT for COVID-19 vaccination attitudes, intentions, misperceptions, and news discernment
8	24	YouGov	2091 U.S., 1090 U.S., 1001 CAD	

### COMPREHENSIVE THINKING STYLES QUESTIONNAIRE ITEM

### FACTOR LOADING

ITEM	FACTOR LOADING			
	1	2	3	4
<b>Factor 1: Preference for Intuitive Thinking</b>				
7. I often go by my instincts when deciding on a course of action.	.86	-.02	-.05	.03
3. When I make decisions, I tend to rely on my intuition.	.86	-.02	.06	-.03
5. Using my "gut-feelings" usually works well for me in figuring out problems in my life.	.81	.02	.01	.06
1. I like to rely on my intuitive impressions.	.80	.00	.00	-.04
2. I believe in trusting my hunches.	.75	.01	-.04	-.05
6. Intuition is the best guide in making decisions.	.70	.02	.00	-.20
<b>Factor 2: Close-minded Thinking</b>				
17. Either something is true or it is false; there is nothing in-between.	.04	.82	.03	.02
18. There is no middle ground between what is true and what is false.	.01	.81	.05	.08
8. In my experience, the truth is often black and white.	-.02	.70	.13	-.13
15. The truth does not change.	.04	.61	-.06	.06
10. Truth is never relative.	-.05	.54	-.01	.05
2. I think there are many wrong ways, but only one right way, to almost anything.	.00	.33	-.16	-.11
<b>Factor 3: Preference for Effortful Thinking</b>				
3. I try to avoid situations that require thinking in depth about something. (R)	-.16	.05	-.77	-.11
2. Thinking is not my idea of an enjoyable activity. (R)	-.10	.00	-.71	-.13
1. I'm not that good at figuring out complicated problems. (R)	.02	-.03	-.64	.13
4. I am not a very analytical thinker. (R)	.09	-.04	-.62	.03
5. Reasoning things out carefully is not one of my strong points. (R)	.02	-.04	-.62	-.01
6. Thinking hard and for a long time about something gives me little satisfaction. (R)	.12	.08	-.50	-.03
<b>Factor 4: Actively Open-minded Thinking</b>				
1. It is important to be loyal to your beliefs even when evidence is brought to bear against them. (R)	-.04	.02	.00	-.81
20. Even if there is concrete evidence against what you believe to be true, it is OK to maintain cherished beliefs. (R)	.00	-.04	-.01	-.79
17. Just because evidence conflicts with my current beliefs does not mean my beliefs are wrong. (R)	.02	-.02	.05	-.73
18. There may be evidence that goes against what you believe but that does not mean you have to change them. (R)	.02	.01	-.02	-.72
21. Regardless of the topic, what you believe to be true is more important than evidence against your beliefs. (R)	.08	.03	-.08	-.71
6. Whether something feels true is more important than evidence. (R)	.16	-.05	-.03	-.61

### b. RELIGIOUS BELIEF CHANGE



Results are robust to:  
1. Age, education, gender, income  
2. Different subject pools for studies  
3. Political Ideology (Canada, U.S.A)

### DISCUSSION

- Close-Minded Thinking and Actively Open-Minded Thinking are not mere compliments of each other: they weakly overlap and predict different outcomes.
- Preference for Effortful Thinking (PET) is synonymous with Need for Cognition measure (likely the most commonly used thinking style measure) but PET had generally weaker predictive validity than the other subscales in Studies 7 and 8, especially Actively Open-minded Thinking.
- Measures that rely on a single dimension measure to index thinking styles, (Need for Cognition scale, CRT) may fail to detect cases where intuitive-analytic thinking styles are playing important roles.

People vary across at least four different elements of intuitive-analytic thinking styles which differentially predict diverse outcomes.

