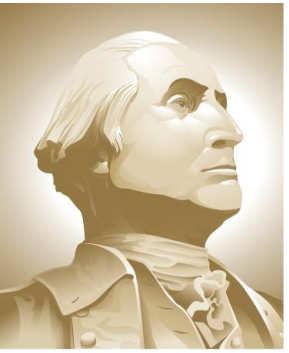

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Surveys, Laboratory Experiments, and Social Media: Better Together

Session on Cultural, Linguistic, and Behavioral Research and the Triangulation of Data

Social and Behavioral Sciences for National Security: A Decadal Survey

Workshop on Culture, Language, and Behavior

October 11, 2017

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The George Washington University

Department of Engineering Management and Systems Engineering

Agenda

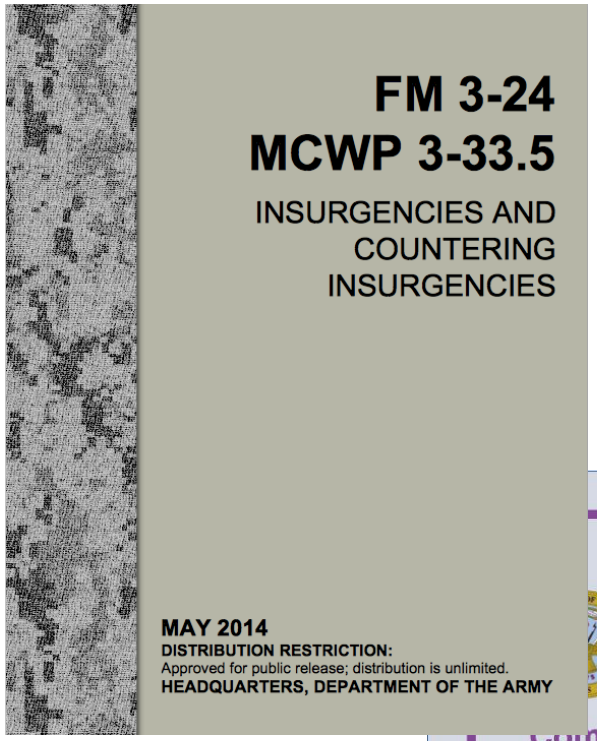
- Overcoming the tradeoff between external and internal validity with data triangulation and multiple methods
- Case example: the effects of online narrative on behavior
- What makes these claims compelling? Fuzzy Trace Theory
- Testing Fuzzy Trace Theory's Predictions in three settings:
  - Laboratory Experiments
  - Surveys
  - Social Media
- Conclusions: Multiple Converging Lines of Evidence

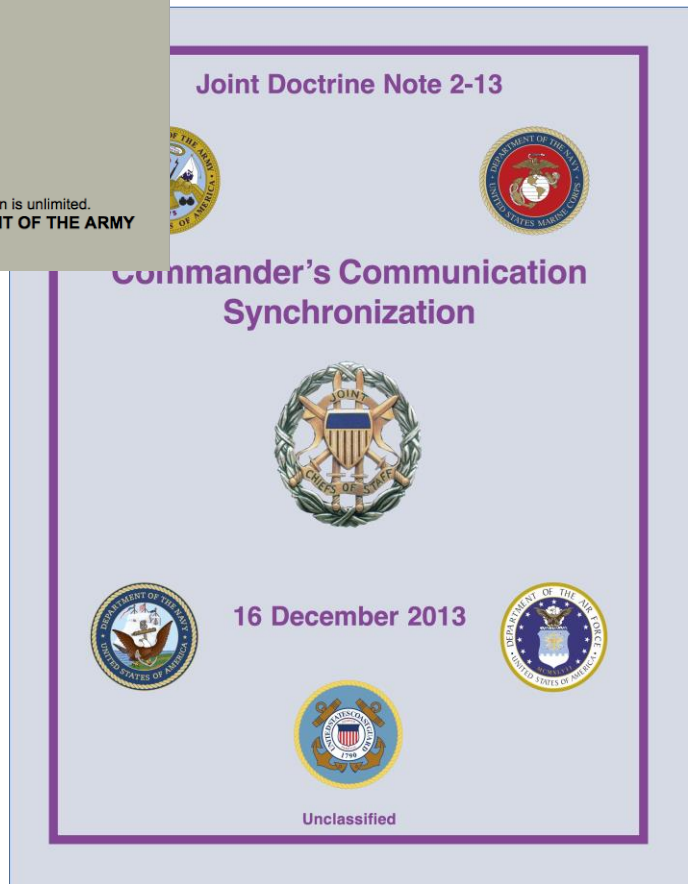
Triangulation of Data and Validity Types

- Key types of research validity (Shadish et al., 2002):
  - Internal: Does the proposed treatment **cause** the proposed effect?
  - External: Does the identified relationship generalize across settings?
  - Construct: Does the study reflect the constructs studied
- One must often trade external validity against internal validity in any single study
- Multiple studies, using several methods and different data sources, can be used to determine if there are converging lines of evidence to support a theory

Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and quasi-experimental designs for generalized causal inference*. Wadsworth Cengage learning.

Case Example: Effect of Narratives on Behavior





- FM 3-24: …As conditions change, **insurgent leaders create different narratives to mobilize a population.** (p. 4-3)
- JDN 2-13: …the "**battle of the narrative**"… **A key component of the narrative is establishing the reasons for and desired outcomes of the conflict, in terms understandable to relevant publics.** pp. ix-x
- "**Social media enables** the rapid transmission of **information and misinformation** to domestic and international publics and communities of interest" p II-13

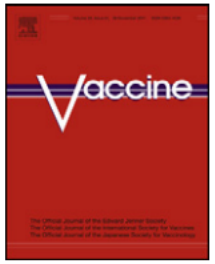
Case Example: Effect of Narratives on Behavior

Vaccine 30 (2012) 3727–3733

Contents lists available at SciVerse ScienceDirect

Vaccine

journal homepage: www.elsevier.com/locate/vaccine



Opportunities and challenges of Web 2.0 for vaccination decisions☆

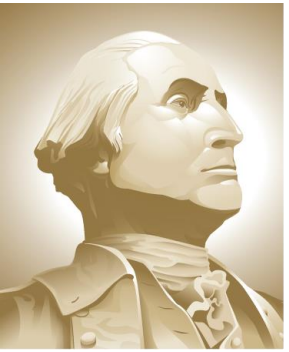
Cornelia Betsch[a,*], Noel T. Brewer[b], Pauline Brocard[c], Patrick Davies[d], Wolfgang Gaissmaier[e], Niels Haase[a], Julie Leask[f], Frank Renkewitz[a], Britta Renner[g], Valerie F. Reyna[h], Constanze Rossmann[i], Katharina Sachse[j], Alexander Schachinger[k], Michael Siegrist[l], Marybelle Stryk[m]

- Narratives have inherent advantages over other communication formats…[and] include all of the key elements of memorable messages: They are easy to understand, concrete, credible … and highly emotional. These qualities make this type of information compelling…" (p. 3730)

Why are these claims compelling? Fuzzy Trace Theory

- Effective messages help readers retain the meaning in memory and facilitate availability of the knowledge at the time of behavior implementation
- Two types of memory:
  - Verbatim: precise details
  - Gist memories: basic meaning.
- Decisions tend to be based on gist memories – or the basic meaning – not verbatim facts.
- According to this theory, therefore, websites that produce more coherent and meaningful gist will be more influential (even if they are not factually accurate!).
  - Ex: Child got vaccinated -> child developed autism. Therefore, vaccines cause autism
  - In fact, symptoms of autism appear around the same time as vaccination schedule

Reyna, V. F. (2012). Risk perception and communication in vaccination decisions: a fuzzy-trace theory approach. *Vaccine*, *30*(25), 3790–3797.



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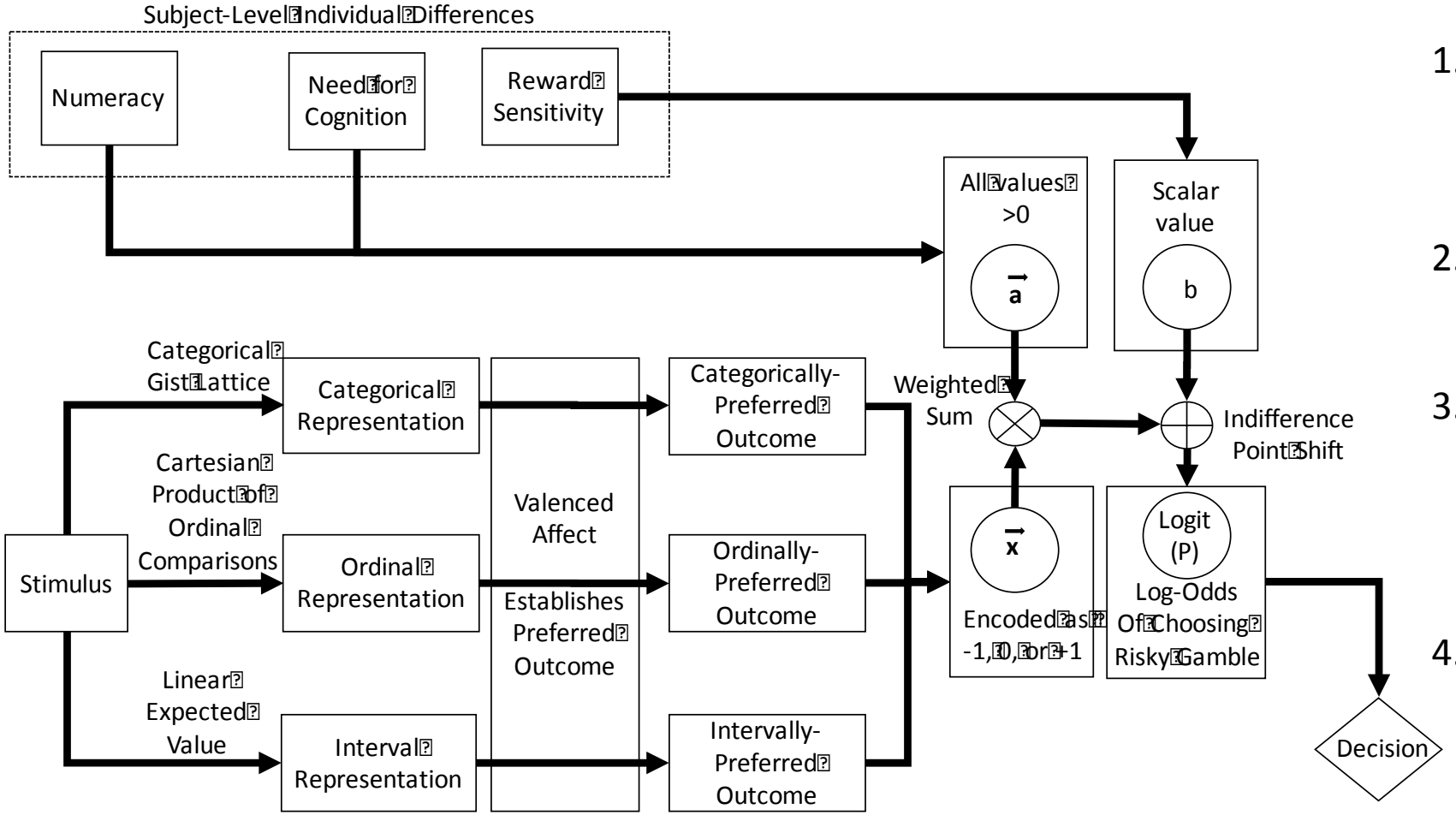
Experiments

Internal Validity

Allows for Process-Level Mathematical Modeling

Tests link between perception and decision

Schematic Model of Fuzzy Trace Theory (FTT)



1. Decisions are encoded at detailed ***verbatim*** level and abstract ***gist*** level simultaneously. Gist encodes ***meaning.***
2. Categorical gist interpretation is preferred ("fuzzy processing preference")
3. Subjects simultaneously encode ***more precise*** representations ("hierarchy of gist")
   - Ordinal
   - Interval
4. Choices between gist categories are made based on ***values***

Preferred category will be selected

Broniatowski, D. A., & Reyna, V. F. (2017). A Formal Model of Fuzzy-Trace Theory: Variations on Framing Effects and the Allais Paradox. *Decision*. https://doi.org/10.1037/dec0000083

Empirical Tests of FTT: Framing Problems

Imagine that the U.S. is preparing for the outbreak of an unusual Asian disease, which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume that the exact scientific estimates of the consequences of the program are as follows:

If Program A is adopted, 200 people will be saved/die [**72**%/**22**%]

If Program B is adopted, there is a 1/3 probability that 600 people will be saved and a 2/3 probability that no people will be saved/die." [**28**%/**78**%] (Tversky & Kahneman, 1981)

Tversky, A., & Kahneman, D. (1981). The framing of decisions and the psychology of choice. *Science*, *211*(4481), 453–458.

The Truncation Problem

(e.g., Reyna et al., 2014)

Imagine that the U.S. is preparing for the outbreak of an unusual Asian disease, which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume that the exact scientific estimates of the consequences of the program are as follows:

- If Program A is adopted, 200 people will be saved [~50%]

- If Program B is adopted, there is a 1/3 probability that 600 people will be saved ~~and a 2/3 probability that no people will be saved.~~" [~50%]

Reyna, V. F., Chick, C. F., Corbin, J. C., & Hsia, A. N. (2014). Developmental reversals in risky decision making: Intelligence agents show larger decision biases than college students. *Psychological Science*, *25*(1), 76–84.

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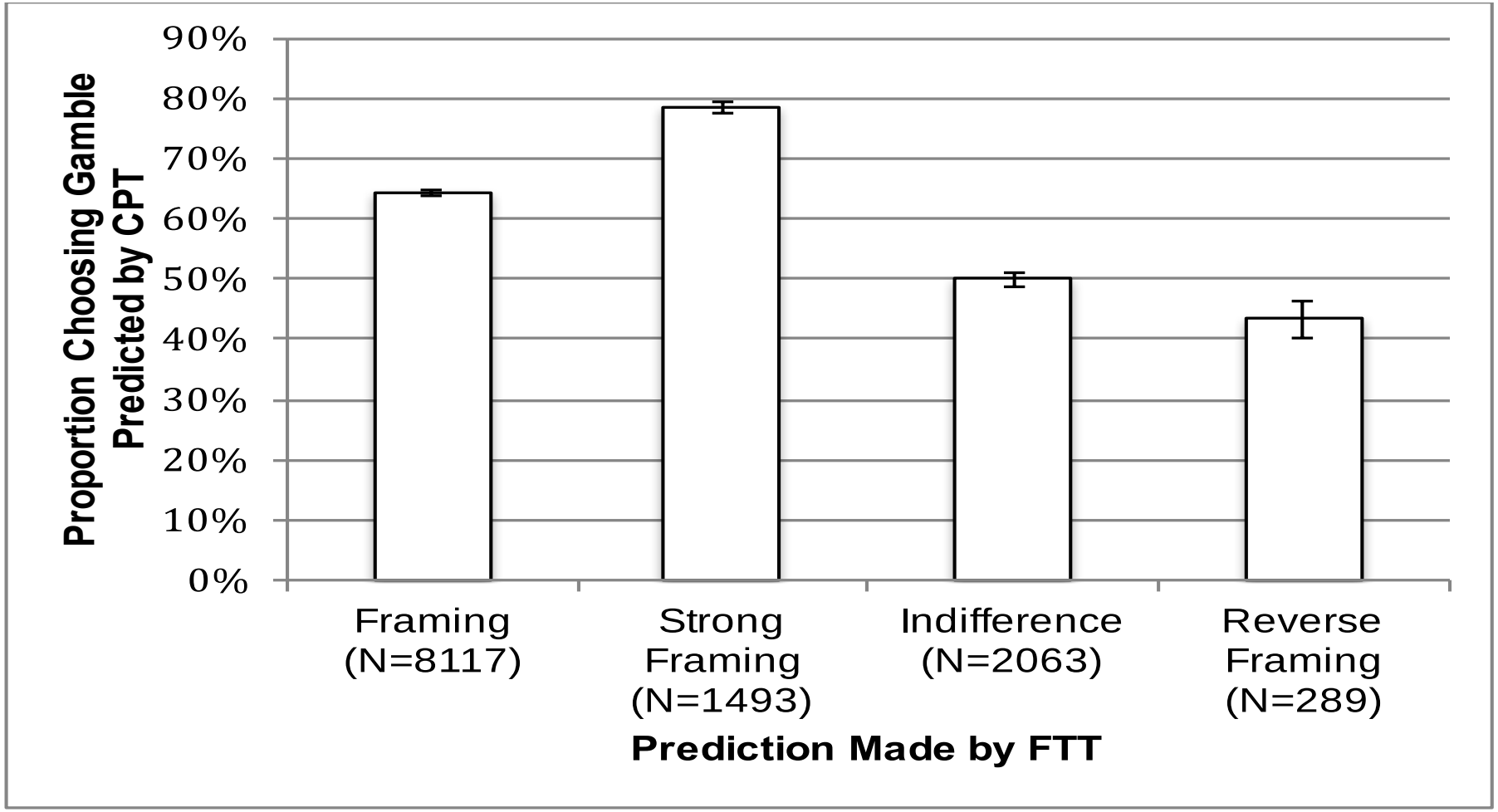
- If Program A is adopted, 200 people will be saved [78%]
- If Program B is adopted, there is a ~~1/3 probability that 600 people will be saved and a~~ 2/3 probability that no people will be saved." [22%] (e.g., Kuehberger & Tanner, 2010)

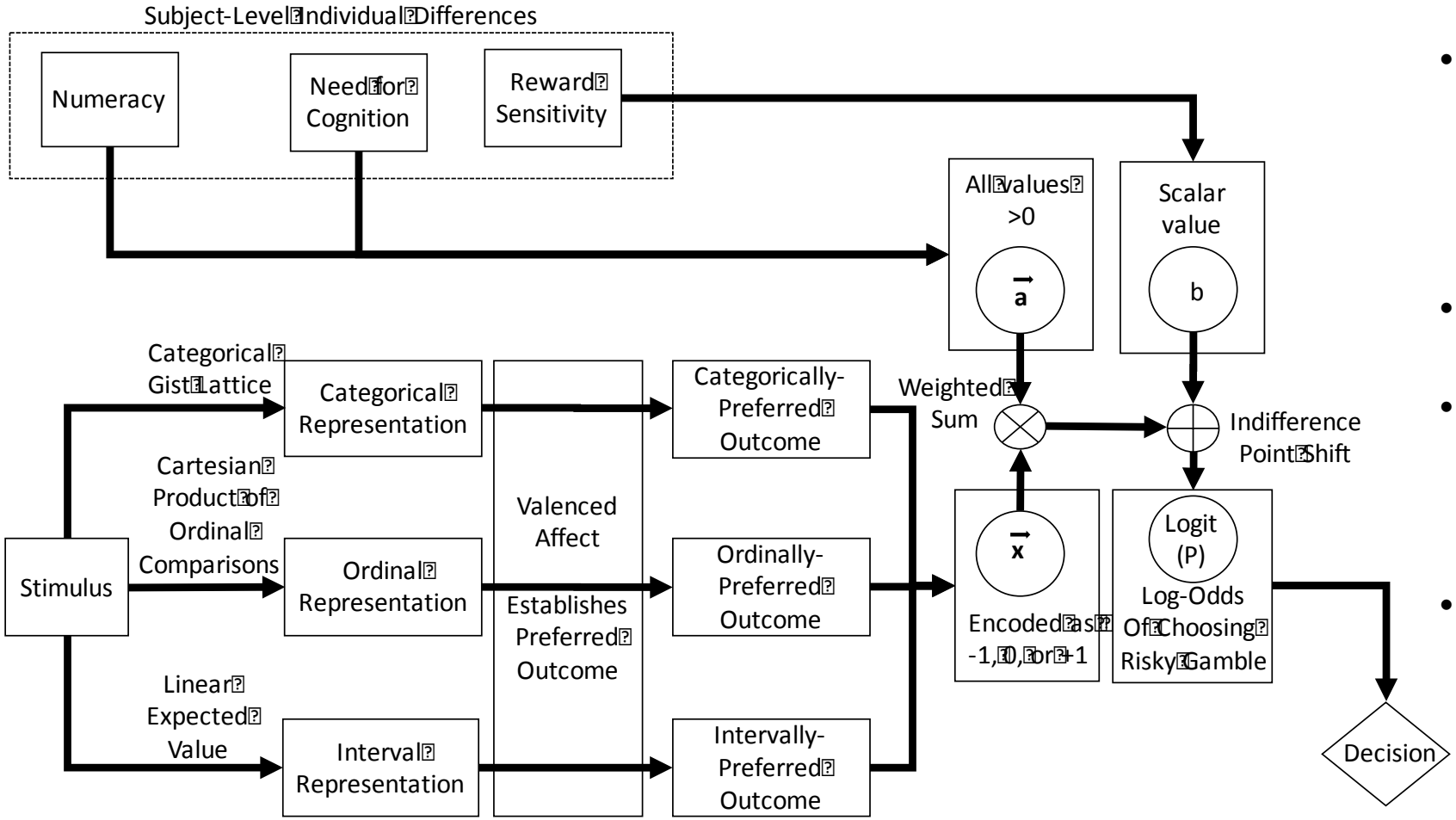
Reyna, V. F., Chick, C. F., Corbin, J. C., & Hsia, A. N. (2014). Developmental reversals in risky decision making: Intelligence agents show larger decision biases than college students. *Psychological Science*, *25*(1), 76–84.

Comparison to Cumulative Prospect Theory



Broniatowski, D. A., & Reyna, V. F. (2017). A Formal Model of Fuzzy-Trace Theory: Variations on Framing Effects and the Allais Paradox. *Decision*. https://doi.org/10.1037/dec0000083

Assessing Model's Goodness of Fit



- Tested model against 88 pairs of framing problems reflecting gain-loss conditions
  - Tested 170 of these problems individually
- Also tested against replications of the Allais Paradox
- Values for model parameters, **a** and b, were estimated using a Jackknife estimator with Leave-One-Out Cross Validation
- Successfully predicted
  - 82/88 (93%) pairs of problems
  - 153/170 (90%) individual problems

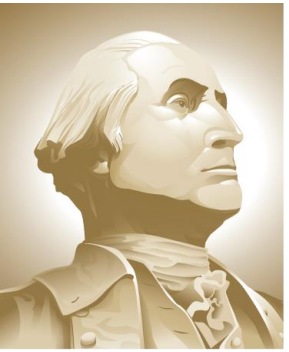
Broniatowski, D. A., & Reyna, V. F. (2017). A Formal Model of Fuzzy-Trace Theory: Variations on Framing Effects and the Allais Paradox. *Decision*. https://doi.org/10.1037/dec0000083

Assessing Model's Goodness-of-Fit

Table 1: Evaluation of Model Fit.

Model	Like-lihood	AIC	BIC
Null (assumes no effect)	-7491	14982	14987
Saturated (overfit to each datapoint)	-6570	13491	14049
Analytic Categories (baseline model)	-6672	13409	13510
Single average value for a and b (reduced model)	-6826	13676	13715

Note. AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion



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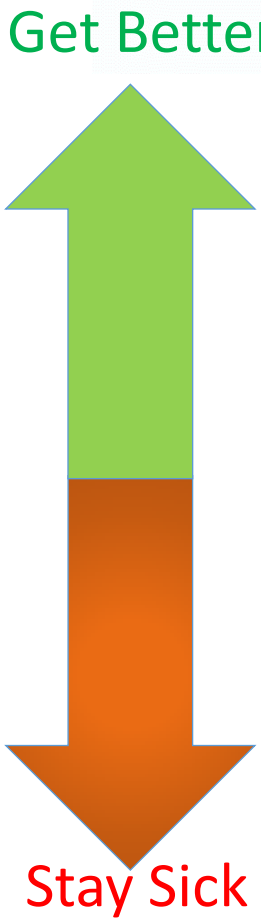
But Does it Generalize Outside the Lab?

Survey Techniques

External Validity: Survey Analysis of Patients and Providers about Antibiotic Overuse

- Hypothesis: “Why Not Take a Risk?” motivated by Fuzzy Trace Theory categorical representation of framing problem
- Status quo: patient is already sick
- Two options
  1. Stay sick for sure (by avoiding antibiotics)
  2. Maybe stay sick; maybe get better (by taking antibiotics)
- Getting better is preferred over staying sick, so choose antibiotics
- Underlying assumptions:
  - There is some chance that antibiotics could make them feel better (see also the anti-inflammatory property of some ABX)
  - Antibiotics are essentially harmless to the individual



Broniatowski, D. A., Klein, E. Y., & Reyna, V. F. (2015). Germs Are Germs, and Why Not Take a Risk? Patients’ Expectations for Prescribing Antibiotics in an Inner-City Emergency Department. *Medical Decision Making*, *35*(1), 60–67. https://doi.org/10.1177/0272989X14553472

Methods: Surveys

- Patients: We administered a paper survey between January and April 2013
  - Survey administered anonymously to 113 patients presenting to ED after they were seen by physician but prior to discharge
- Clinicians: Electronic survey administered to 69 providers between August 2014 and December 2015
- Both surveys contained several Likert-scale questions, driven by prior literature, indexing patients' and providers' perceptions of antibiotic therapy

Klein, E. Y., Martinez, E. M., May, L., Saheed, M., Reyna, V., & Broniatowski, D. A. (2017). Categorical Risk Perception Drives Variability in Antibiotic Prescribing in the Emergency Department: A Mixed Methods Observational Study. *Journal of General Internal Medicine*, *32*(10), 1083–1089. https://doi.org/10.1007/s11606-017-4099-6

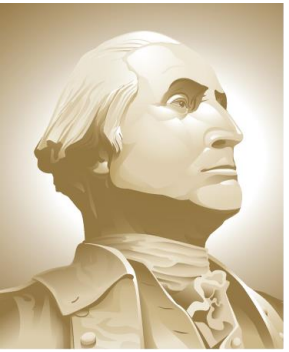
Results Support FTT's predictions

- Perception: 76% of patients endorsed at least one item supporting "Why Not Take a Risk?" (WNTAR)
  - Less than half -- 54 (48%) -- of patients endorsed at least one item supporting the leading alternative hypothesis: that patients don't know the difference between viruses and bacteria ("Germs are Germs")
- In both surveys, WNTAR captured the most unique variance in an exploratory factor analysis
- Behavior: Clinicians who agreed with WNTAR were 28% more likely to prescribe antibiotics: they appear to frame the choice as a categorical contrast between providing a possibly effective treatment and the patient remaining sick.

Klein, E. Y., Martinez, E. M., May, L., Saheed, M., Reyna, V., & Broniatowski, D. A. (2017). Categorical Risk Perception Drives Variability in Antibiotic Prescribing in the Emergency Department: A Mixed Methods Observational Study. *Journal of General Internal Medicine*, *32*(10), 1083–1089. https://doi.org/10.1007/s11606-017-4099-6

Limitations

- Patients: Our study is representative of an urban, low SES ED patient population, but it is not nationally representative.
  - The sickest patients and those experiencing the most pain were less likely to be responsive an more likely to be excluded.
  - Our analysis was not limited to those most likely to expect antibiotics (those with cold- and flu-like symptoms)
    - Most patients expressed some level of support for antibiotic use regardless of current complaint
  - We measured beliefs and attitudes; not changes in behavior.
  - Surveys can be prone to response bias
- Providers: Study was conducted only across two acute care EDs – not a nationally-representative sample
- Studies lack experimental controls for other factors that may drive prescribing (time pressure, inertia, concerns about patient follow-up, decision fatigue, unrealistic estimates of potential complications, etc.)



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Social Media

Retrospective & Observational, yet allows for significantly more data

Study setting: Disneyland measles outbreak

- Began December 2014 at Disneyland in California
- Led to 111 cases in seven states (as well as Canada and Mexico)
- Cases began among unvaccinated people
- Called attention to the issue of herd immunity
- Led to proposals to curtail vaccine refusal through legislative means

Broniatowski, D. A., Hilyard, K. M., & Dredze, M. (2016). Effective vaccine communication during the Disneyland measles outbreak. *Vaccine*. http://doi.org/10.1016/j.vaccine.2016.04.044

Statistics, Stories…. or gist?

- Ongoing debate: Does including a story lead to more effective communications than presenting ”just the facts” (i.e., statistical data)?
  - Hesitance to include stories because of concerns of appearing biased
- Fuzzy Trace Theory (Reyna, 2012)
  - Verbatim representation (statistical details)
    - ”Measles can lead to pneumonia, deafness, lifelong brain damage, and even death, and almost 1/3 of children with measles have to be hospitalized”
  - Gist: Communicates bottom-line meaning
    - ”Taking any risk that your child could get the measles and suffer serious complications isn’t worth it. Vaccination is the best way to protect your child”
  - Stories are effective because they communicate a gist.
    - Also **cue** motivationally relevant moral and social principles

Reyna, V. F. (2012). Risk perception and communication in vaccination decisions: A fuzzy-trace theory approach. *Vaccine*, *30*(25), 3790–3797.

Analysis of measles media coverage

- Coded 4,581 out of a collection of 39,351 outbreak-related articles published from November 2014 to March 2015
- Measured shares on Facebook
- Used M-Turk to categorize article content:
- 1) statistics about viruses or vaccines
  2) ”gist”, or bottom line meaning
  - Positive or negative summary opinion about endorsing or opposing vaccination
- 3) Other expected covariates based on prior literature

Broniatowski, D. A., Hilyard, K. M., & Dredze, M. (2016). Effective vaccine communication during the disneyland measles outbreak. *Vaccine*. http://doi.org/10.1016/j.vaccine.2016.04.044

What led to article shares:

- Results are consistent with Fuzzy Trace Theory
  - Significant effects of gist and verbatim, but NOT stories
- Stories are effective to the extent that they communicate gist
- Among articles with gists shared at least once (n=257)Articles expressing positive opinions about those endorsing vaccination AND those opposing vaccination were 57.8 times more likely to be shared

Coefficients of logistic regression analysis for whether an article was shared at least once on Facebook ($n = 4580$, df = 10).

	β	SE β	z-value	OR
Length	-5.56×10^{-4}	8.93×10^{-5}	-6.22^{***}	1.00
Readability	-7.23×10^{-4}	1.49×10^{-3}	−0.49	1.00
Image	0.59	0.09	6.91^{***}	1.80
Stories	0.34	0.19	1.82	1.41
Statistics	0.29	0.08	3.48^{***}	1.33
Gist	0.82	0.15	5.36^{***}	2.27
Stories × Statistics	0.05	0.22	0.24	1.05
Stories × Gist	0.25	0.32	0.80	1.29
Statistics × Gist	−0.17	0.20	−0.85	0.85
Stories × Statistics × Gist	−0.35	0.40	−0.89	0.70
(Intercept)	−1.08	0.12	-8.91^{***}	

Note. $^{***} = p < 0.001$. β = logistic regression coefficient; SE β = standard error of β; OR = Odds Ratio.

Broniatowski, D. A., Hilyard, K. M., & Dredze, M. (2016). Effective vaccine communication during the disneyland measles outbreak. *Vaccine*. http://doi.org/10.1016/j.vaccine.2016.04.044

Conclusion: Multiple Converging Lines of Evidence

- Although an individual study may possess weaknesses in one aspect of validity, an ensemble of studies allows more confidence in conclusions.
- National security and public health practitioners face similar challenges from narratives on social media
  - Online organized misinformation and/or disinformation campaigns can undermine public health and national security
- Results across multiple settings support Fuzzy Trace Theory's predictions, providing insight into the spread of online misinformation and disinformation
- Future work: uncovering the specific mechanisms driving online sharing behavior

This work was partially funded by a grant from the National Institute of General Medical Sciences of the National Institutes of Health