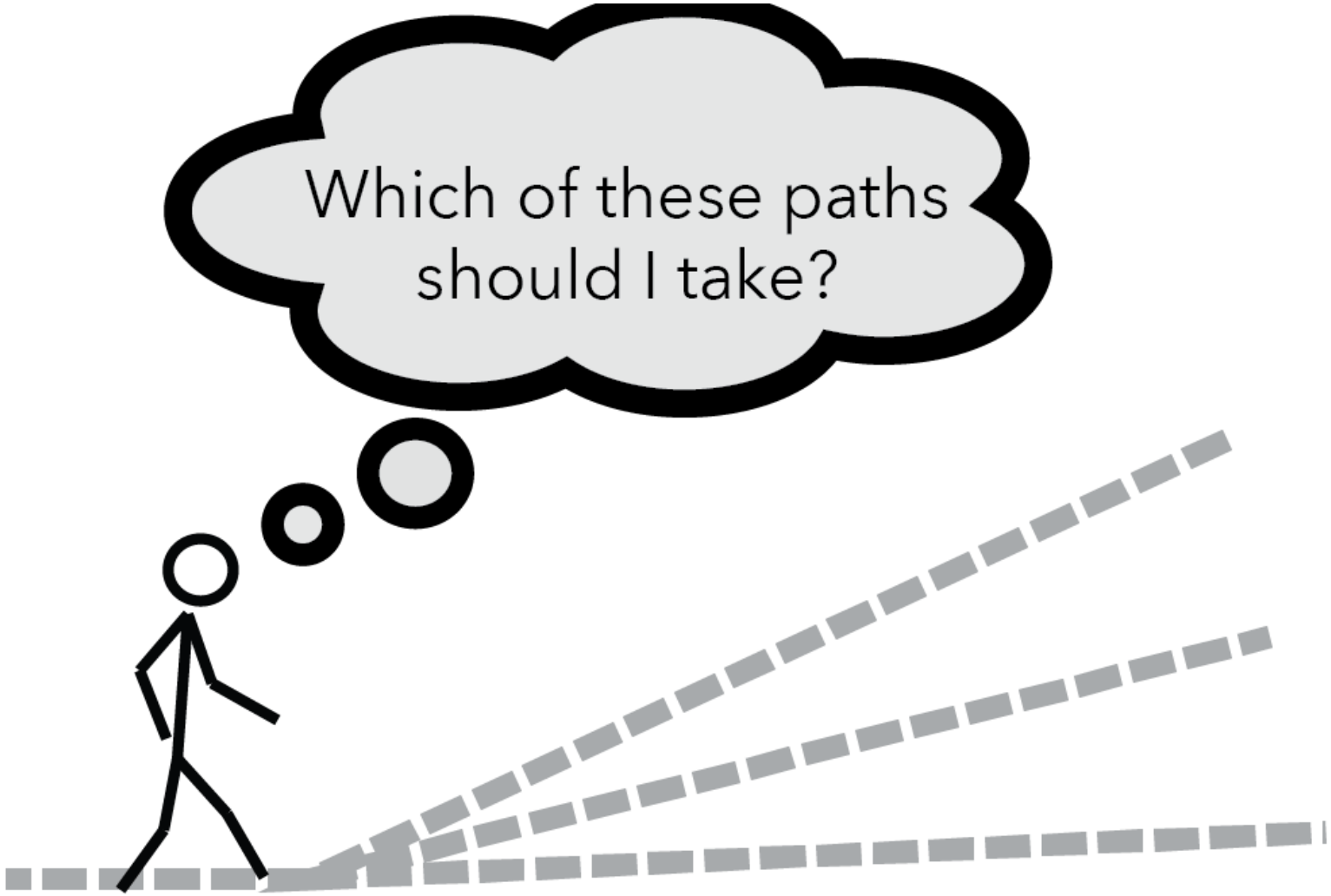
Designing for Epistemic Uncertainty in Research Synthesis

Alex Kale
Sarah Lee
TJ Goan
Matthew Kay
Elizabeth Tipton
Jessica Hullman

Epistemic uncertainty and evidence aggregation

Science is full of decision points



Gelman & Loken 2014

Scientific literature is messy

JAMDA

journal homepage: www.jamda.com

Original Study

The Psychosocial Effects of a Companion Robot: A Randomized Controlled Trial

Hayley Robinson MSc [a], Bruce MacDonald PhD [b], Ngaire Kerse PhD [c], Elizabeth Broadbent PhD [a,*]

[a] Department of Psychological Medicine, The University of Auckland, Auckland, New Zealand
[b] Department of Electrical and Computer Engineering, The University of Auckland, Auckland, New Zealand
[c] Department of General Practice and Primary Health Care, The University of Auckland, Auckland, New Zealand

Keywords:
Robotics
Pets
loneliness
depression
quality of life
human-robot interaction

ABSTRACT

Objectives: To investigate the psychosocial effects of the companion robot, Paro, in a rest home/hospital setting in comparison to a control group.
Design: Randomized controlled trial. Residents were randomized to the robot intervention group or a control group that attended normal activities instead of Paro sessions. Sessions took place twice a week for an hour over 12 weeks. Over the trial period, observations were conducted of residents' social behavior when interacting as a group with the robot. As a comparison, observations were also conducted of all the residents during general activities when the resident dog was or was not present.
Setting: A residential care facility in Auckland, New Zealand.
Participants: Forty residents in hospital and rest home care.
Measurements: Residents completed a baseline measure assessing cognitive status, loneliness, depression, and quality of life. At follow-up, residents completed a questionnaire assessing loneliness, depression, and quality of life. During observations, behavior was noted and collated for instances of talking and stroking the dog/robot.
Results: In comparison with the control group, residents who interacted with the robot had significant decreases in loneliness over the period of the trial. Both the resident dog and the seal robot made an impact on the social environment in comparison to when neither was present. Residents talked to and touched the robot significantly more than the resident dog. A greater number of residents were involved in discussion about the robot in comparison with the resident dog and conversation about the robot occurred more.
Conclusion: Paro is a positive addition to this environment and has benefits for older people in nursing home care. Paro may be able to address some of the unmet needs of older people that a resident animal may not, particularly relating to loneliness.

The growing aging population is a major concern for the future.[1] An increasing number of older people will require formal long term care as their health deteriorates and they cannot source as much human care and support in the community.[2,3] For an older person, admission to an elder care facility is rarely easy and is not a highly anticipated milestone in a person's life.[4] Moving to a nursing home is often precipitated by the loss of a loved one, an inability to look after oneself, declining health, and a lack of control over one's life.[5] These factors, combined with the institutional environment of elder care facilities, means that older people lose aspects of their lives that constitute high life satisfaction.[6] Older people in nursing homes often report feelings of helplessness, boredom, and isolation,[7] increasing their risk of depression[8–11] and loneliness,[12,13] and in general they report a lower quality of life than those residing in the community.[14] Older people may experience problems in nursing homes upon shifting, because residents may find they have fewer of the social connections that previously gave their life meaning. Even when older people have become used to their new living environment, often the feeling of loneliness and isolation does not abate over time as they find it difficult to form new relationships with the people around them.[9] Research has found that there are negative effects on health for older people after entering formal care. Some early studies have reported that there is a high mortality rate among the aged due to institutionalization,[15] whereas other research has found that moving frail elderly from one setting to another results in mental and physical deterioration.[16,17]

Many nursing homes now incorporate animal visitations and interactions into care models. Animals help fulfill criteria aimed at promoting better quality of life by increasing social interactions, decreasing loneliness, countering boredom, and helping foster

No conflicts of interest. Australian New Zealand Clinical Trials Registry (Trial Number: 12612000680810).
* Address correspondence to Elizabeth Broadbent, PhD, University of Auckland, Private Bag 92019, Auckland, New Zealand.
E-mail address: e.broadbent@auckland.ac.nz (E. Broadbent).

1525-8610/$ - see front matter
http://dx.doi.org/10.1016/j.jamda.2013.02.003

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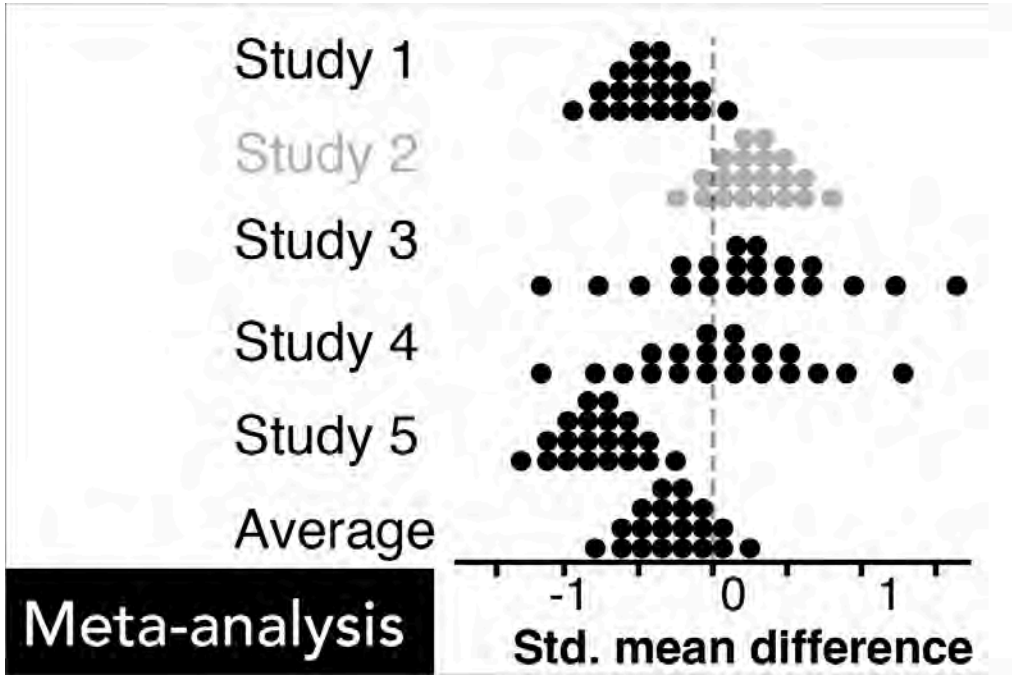


Evidence aggregation

Systematic review

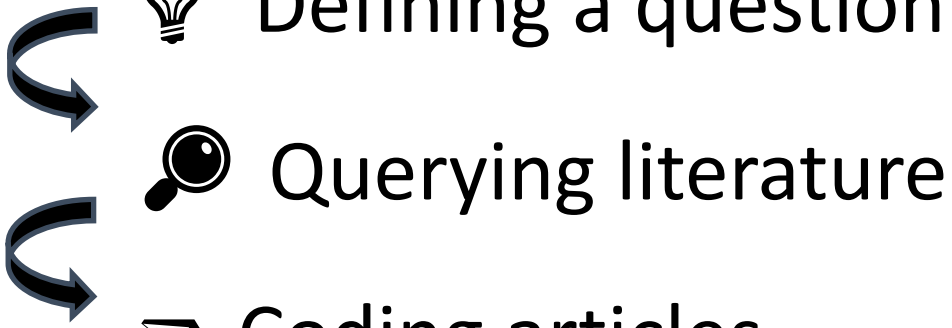
Defining a question

Querying literature

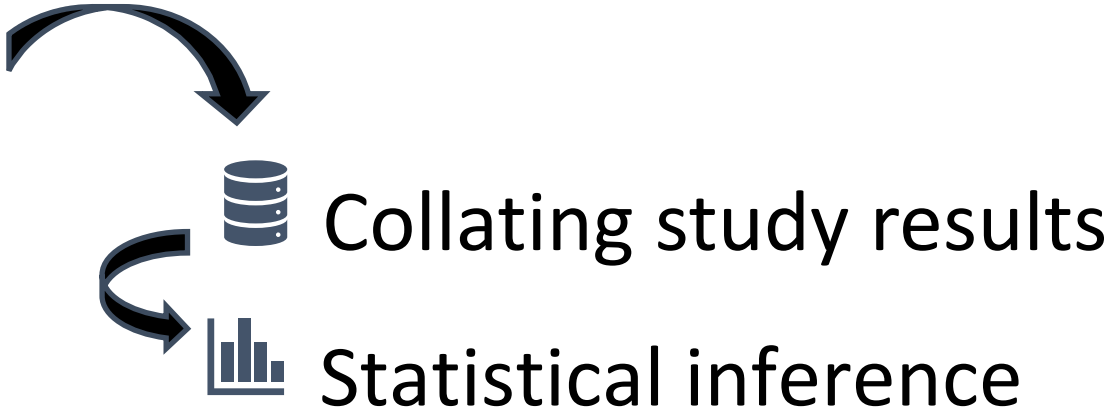
Coding articles

Evidence aggregation

Systematic review



Meta-analysis



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Hayley Robinson MSc[a], Bruce MacDonald PhD[b], Ngaire Kerse PhD[c], Elizabeth Broadbent PhD[a,*]

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Conclusion: Paro is a positive addition to this environment and has benefits for older people in nursing home care. Paro may be able to address some of the unmet needs of older people that a resident animal may not, particularly relating to loneliness.

Keywords: Robotics, Paro, loneliness, depression, quality of life, human-robot interaction

The growing aging population is a major concern for the future.[1] An increasing number of older people will require formal long term care as their health deteriorates and they cannot source as much human care and support in the community.[1,2] For an older person, admission to an elder care facility is rarely easy and is not a highly anticipated milestone in a person's life.[4] Moving to a nursing home is often precipitated by the loss of a loved one, an inability to look after oneself, declining health, and a lack of control over one's life.[5] These factors, combined with the institutional environment of elder care facilities, means that older people lose aspects of their lives that constitute high life satisfaction.[6] Older people in nursing homes often report feelings of helplessness, boredom, and isolation,[7] increasing their risk of depression[8–11] and loneliness,[12,13] and in general they report a lower quality of life than those residing in the community.[14] Older people may experience problems in nursing homes upon shifting, because residents may find they have fewer of the social connections that previously gave their life meaning. Even when older people have become used to their new living environment, often the feeling of loneliness and isolation does not abate over time as they find it difficult to form new relationships with the people around them.[9] Research has found that there are negative effects on health for older people after entering formal care. Some early studies have reported that there is a high mortality rate among the aged due to institutionalization,[15] whereas other research has found that moving frail elderly from one setting to another results in mental and physical deterioration.[16,17]

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1525-8610/$ - see front matter

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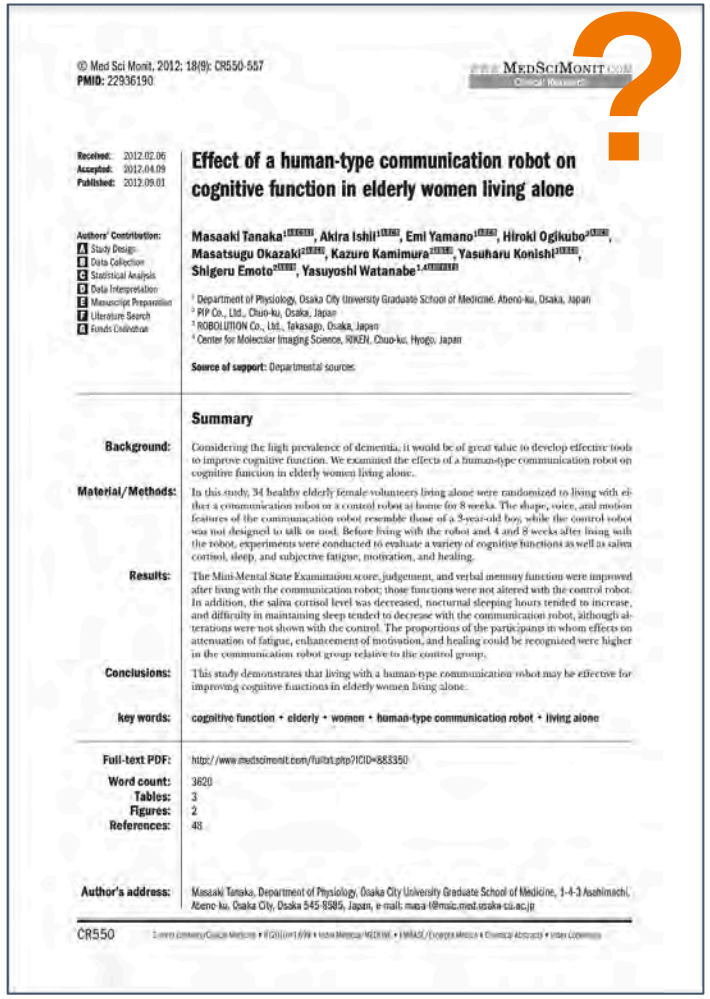


© Med Sci Monit, 2012; 18(9): CR550-557
PMID: 22936190

MEDSCIMONIT.COM
Clinical Research

Received: 2012.02.06
Accepted: 2012.04.09
Published: 2012.09.01

Effect of a human-type communication robot on cognitive function in elderly women living alone

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Data Interpretation
E Manuscript Preparation
F Literature Search
G Funds Collection

Masaaki Tanaka[1,2,3,4], Akira Ishii[1,2], Emi Yamano[1,2], Hiroki Ogikubo[2,3], Masatsugu Okazaki[2,3], Kazuro Kamimura[2,3], Yasuharu Konishi[2,3], Shigeru Emoto[2,3], Yasuyoshi Watanabe[1,4]

[1] Department of Physiology, Osaka City University Graduate School of Medicine, Abeno-ku, Osaka, Japan
[2] PIP Co., Ltd., Chuo-ku, Osaka, Japan
[3] ROBOLUTION Co., Ltd., Takasago, Osaka, Japan
[4] Center for Molecular Imaging Science, RIKEN, Chuo-ku, Hyogo, Japan

Source of support: Departmental sources

Summary

Background: Considering the high prevalence of dementia, it would be of great value to develop effective tools to improve cognitive function. We examined the effects of a human-type communication robot on cognitive function in elderly women living alone.

Material/Methods: In this study, 34 healthy elderly female volunteers living alone were randomized to living with either a communication robot or a control robot at home for 8 weeks. The shape, voice, and motion features of the communication robot resemble those of a 3-year-old boy, while the control robot was not designed to talk or nod. Before living with the robot and 4 and 8 weeks after living with the robot, experiments were conducted to evaluate a variety of cognitive functions as well as salivary cortisol, sleep, and subjective fatigue, motivation, and healing.

Results: The Mini-Mental State Examination score, judgement, and verbal memory function were improved after living with the communication robot; those functions were not altered with the control robot. In addition, the salivary cortisol level was decreased, nocturnal sleeping hours tended to increase, and difficulty in maintaining sleep tended to decrease with the communication robot, although alterations were not shown with the control. The proportions of the participants in whom effects on attenuation of fatigue, enhancement of motivation, and healing could be recognized were higher in the communication robot group relative to the control group.

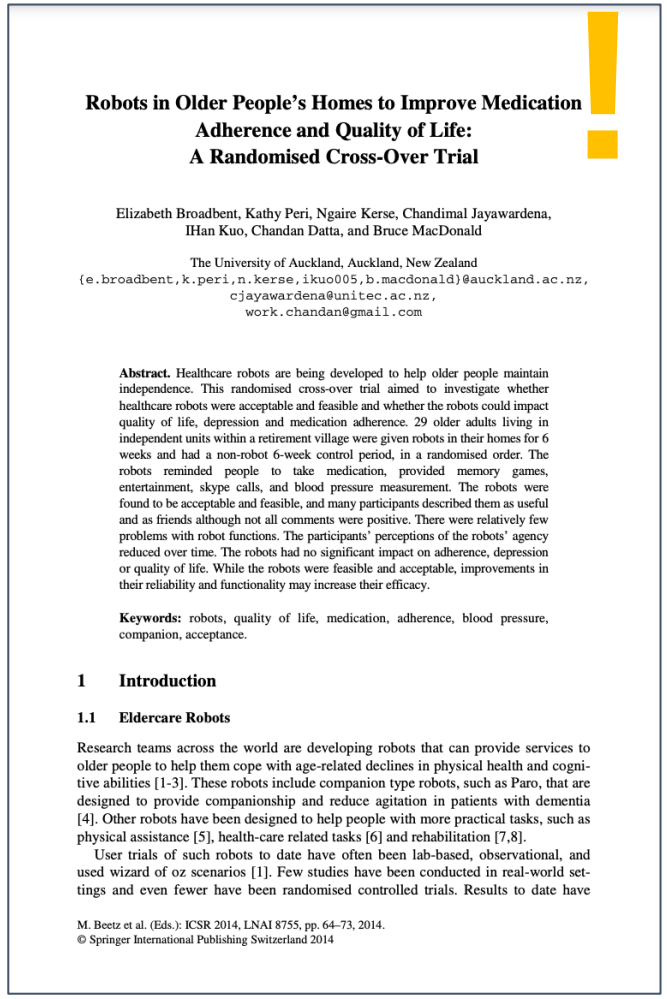
Conclusions: This study demonstrates that living with a human-type communication robot may be effective for improving cognitive functions in elderly women living alone.

key words: cognitive function • elderly • women • human-type communication robot • living alone

Full-text PDF: http://www.medscimonit.com/fulltxt.php?ICID=883350

Word count: 3620
Tables: 3
Figures: 2
References: 48

Author's address: Masaaki Tanaka, Department of Physiology, Osaka City University Graduate School of Medicine, 1-4-3 Asahimachi, Abeno-ku, Osaka City, Osaka 545-8585, Japan, e-mail: masa-t@msic.med.osaka-cu.ac.jp



Robots in Older People's Homes to Improve Medication Adherence and Quality of Life: A Randomised Cross-Over Trial

Elizabeth Broadbent, Kathy Peri, Ngaire Kerse, Chandimal Jayawardena, IHan Kuo, Chandan Datta, and Bruce MacDonald

The University of Auckland, Auckland, New Zealand
{e.broadbent,k.peri,n.kerse,ikuo005,b.macdonald}@auckland.ac.nz, cjayawardena@unitec.ac.nz, work.chandan@gmail.com

Abstract. Healthcare robots are being developed to help older people maintain independence. This randomised cross-over trial aimed to investigate whether healthcare robots were acceptable and feasible and whether the robots could impact quality of life, depression and medication adherence. 29 older adults living in independent units within a retirement village were given robots in their homes for 6 weeks and had a non-robot 6-week control period, in a randomised order. The robots reminded people to take medication, provided memory games, entertainment, skype calls, and blood pressure measurement. The robots were found to be acceptable and feasible, and many participants described them as useful and as friends although not all comments were positive. There were relatively few problems with robot functions. The participants' perceptions of the robots' agency reduced over time. The robots had no significant impact on adherence, depression or quality of life. While the robots were feasible and acceptable, improvements in their reliability and functionality may increase their efficacy.

Keywords: robots, quality of life, medication, adherence, blood pressure, companion, acceptance.

1 Introduction

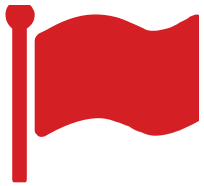
1.1 Eldercare Robots

Research teams across the world are developing robots that can provide services to older people to help them cope with age-related declines in physical health and cognitive abilities [1-3]. These robots include companion type robots, such as Paro, that are designed to provide companionship and reduce agitation in patients with dementia [4]. Other robots have been designed to help people with more practical tasks, such as physical assistance [5], health-care related tasks [6] and rehabilitation [7,8].

User trials of such robots to date have often been lab-based, observational, and used wizard of oz scenarios [1]. Few studies have been conducted in real-world settings and even fewer have been randomised controlled trials. Results to date have

M. Beetz et al. (Eds.): ICSR 2014, LNAI 8755, pp. 64–73, 2014.

Things that make meta-analysis hard



Risk of bias

?

Measurement consistency

!

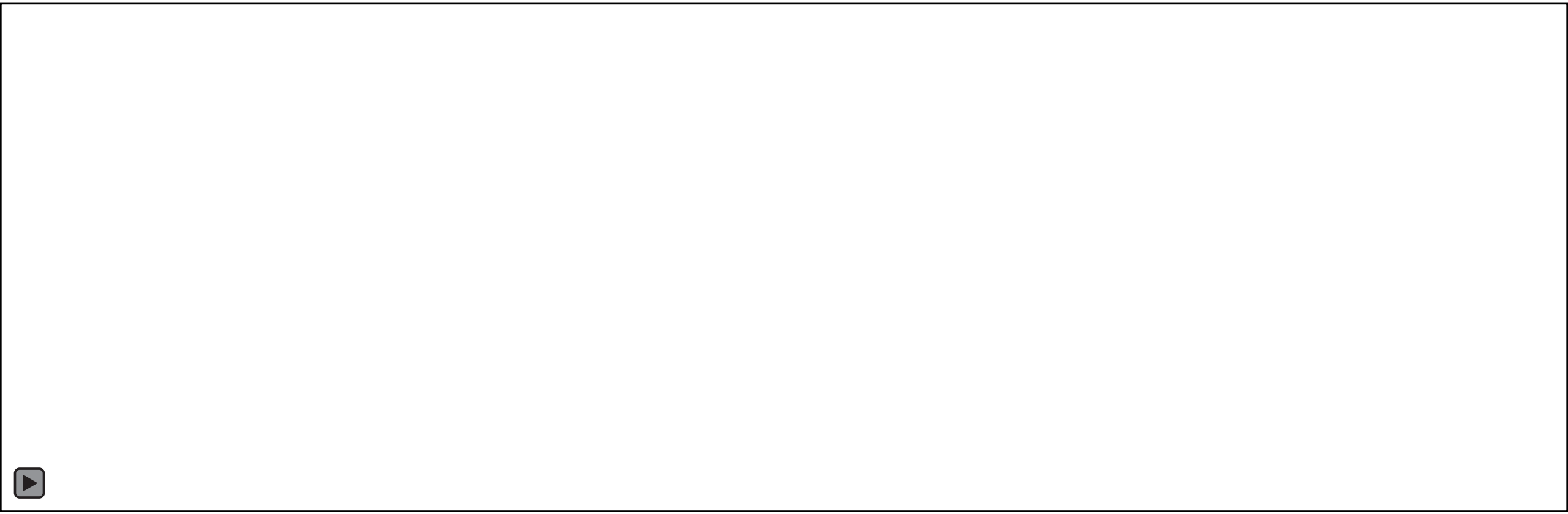
Applicability to target context

Sources of epistemic uncertainty

MetaExplorer

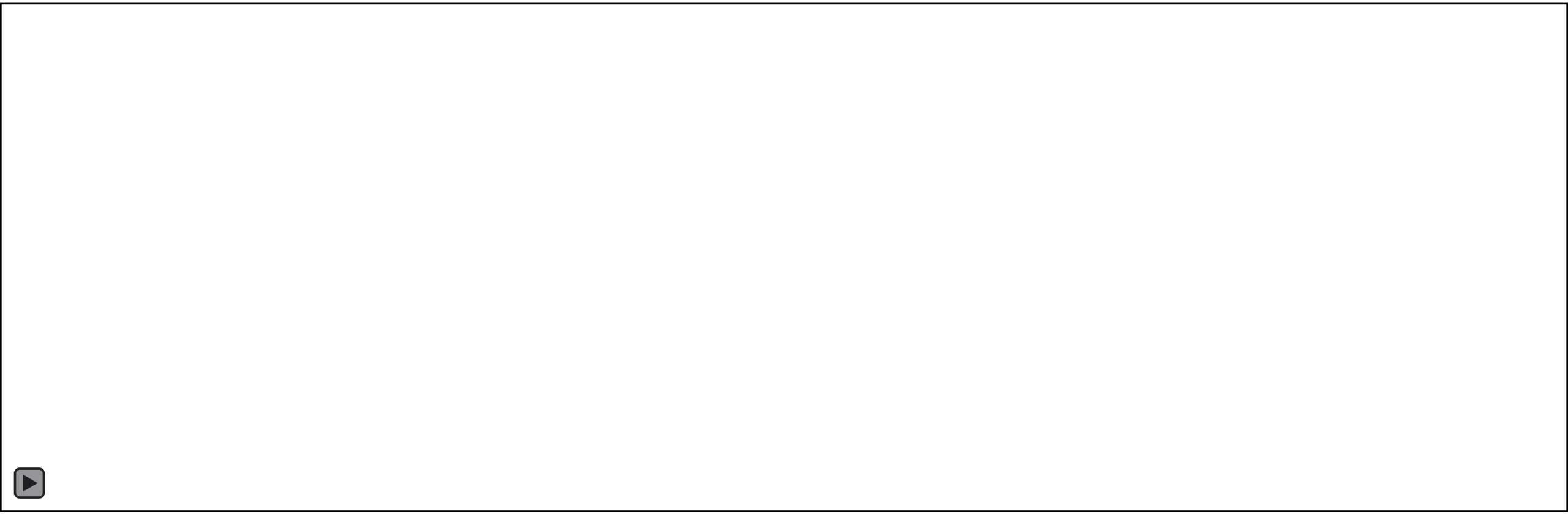
MetaExplorer

Scoping view



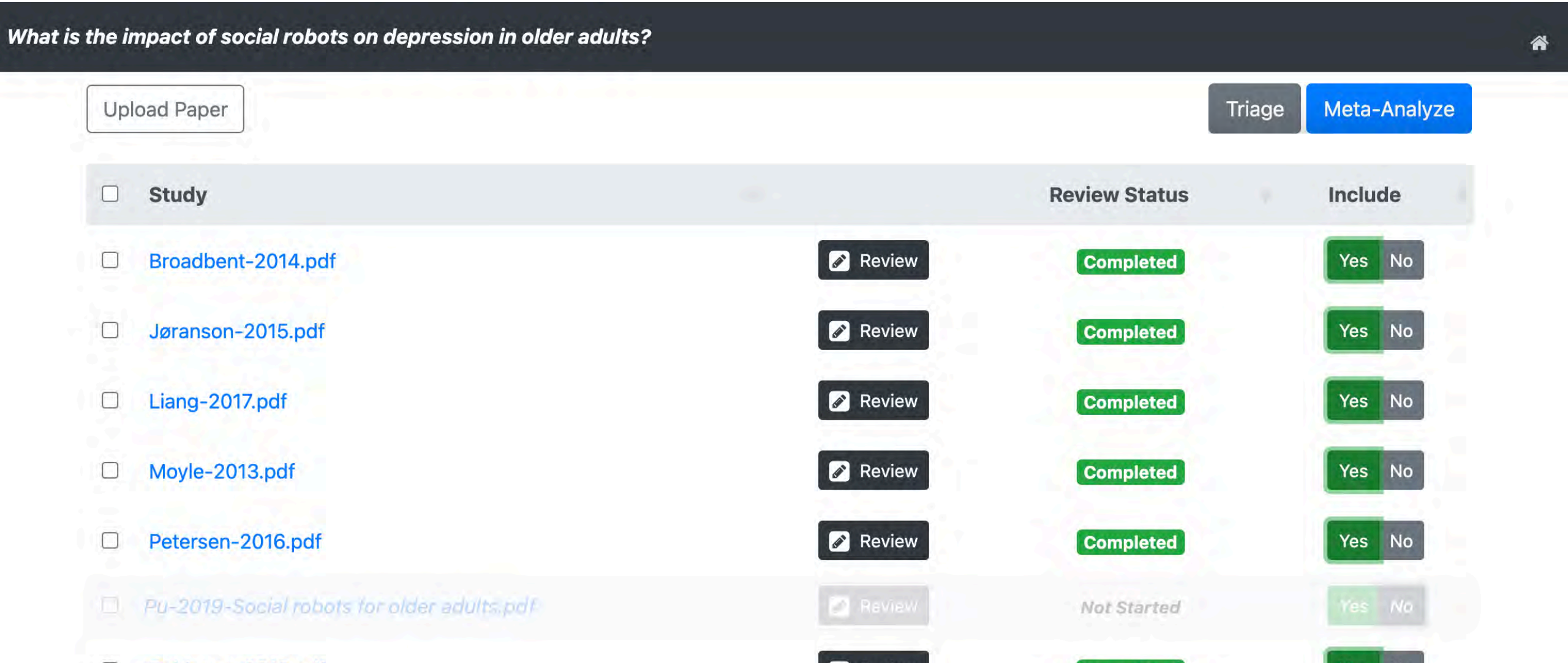
MetaExplorer

Scoping view



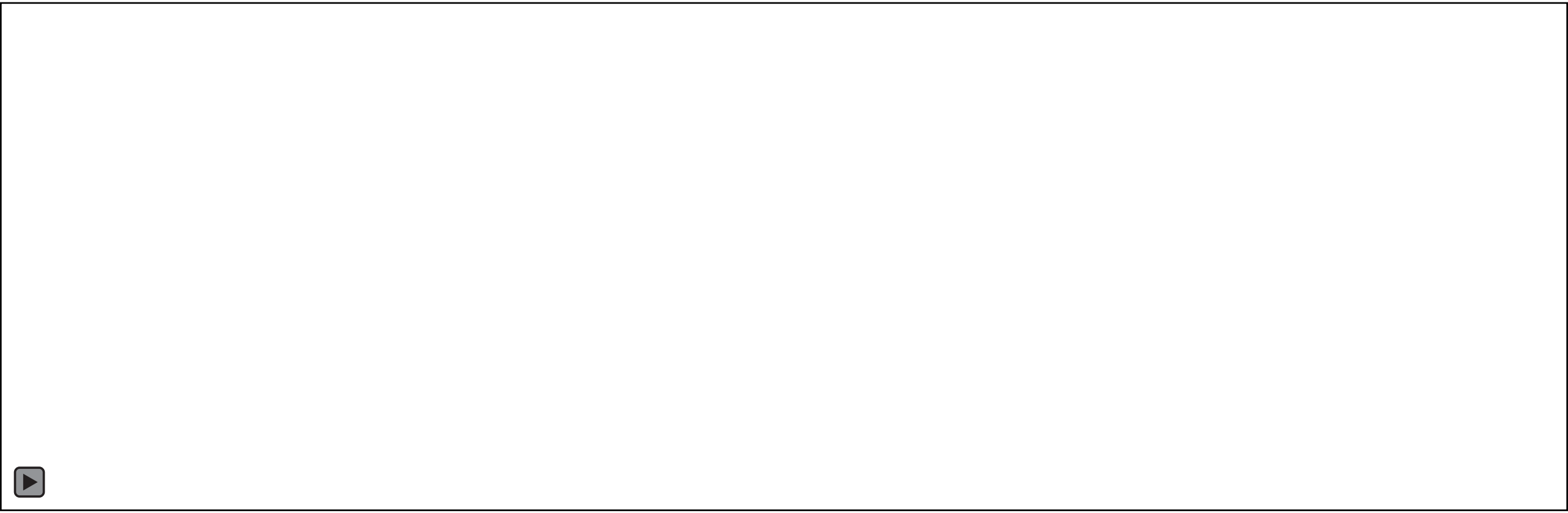
MetaExplorer

Review management



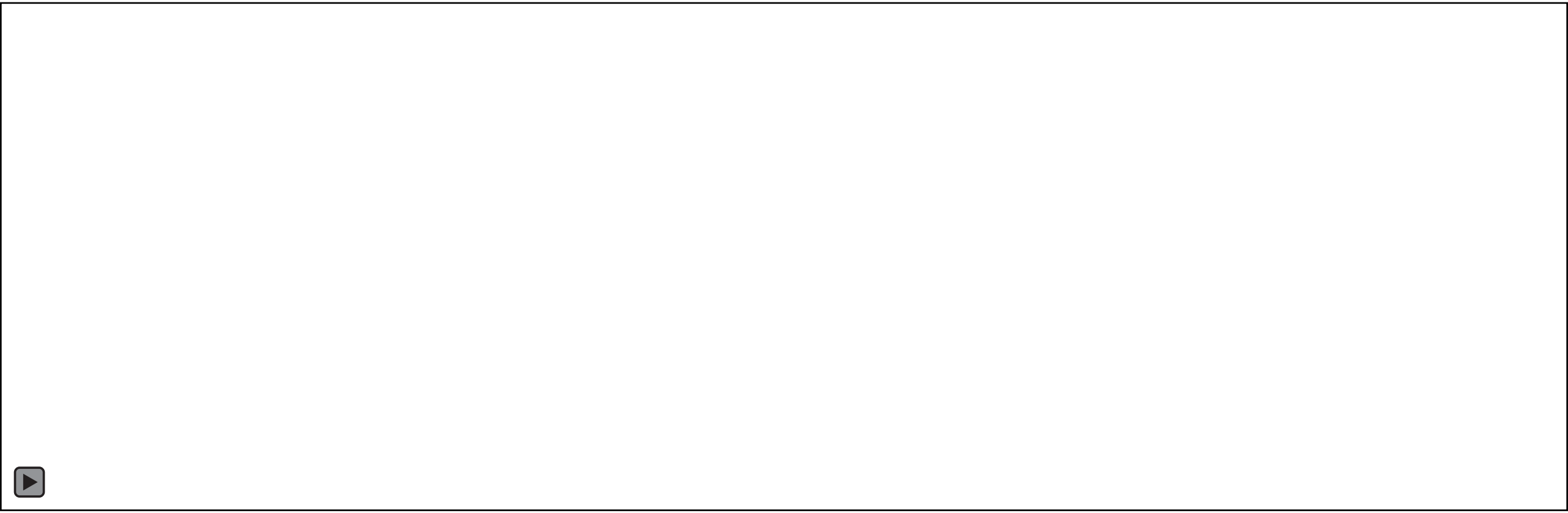
MetaExplorer

Evidence extraction



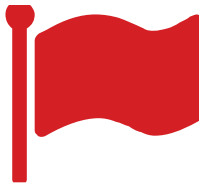
MetaExplorer

Evidence extraction



MetaExplorer

Triage view



Risk of bias

> Flag the study result

?

Measurement consistency

> Meta-analyze separately

!

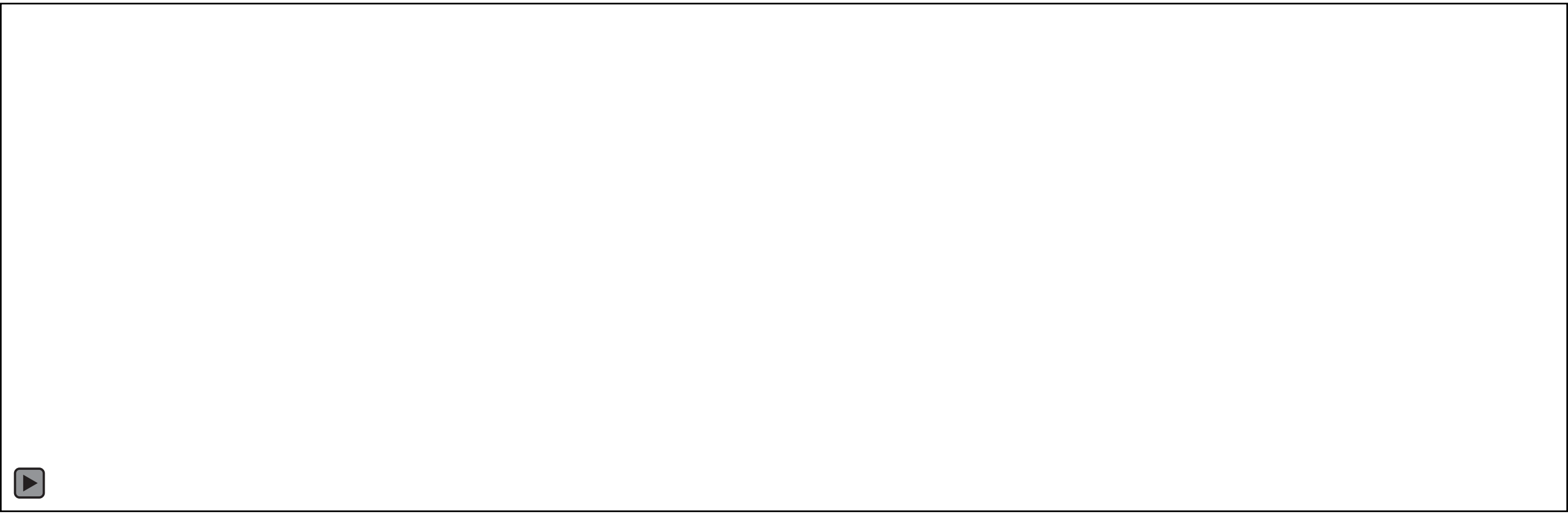
Applicability to target context

> Show, but don’t meta-analyze

Sources of epistemic uncertainty

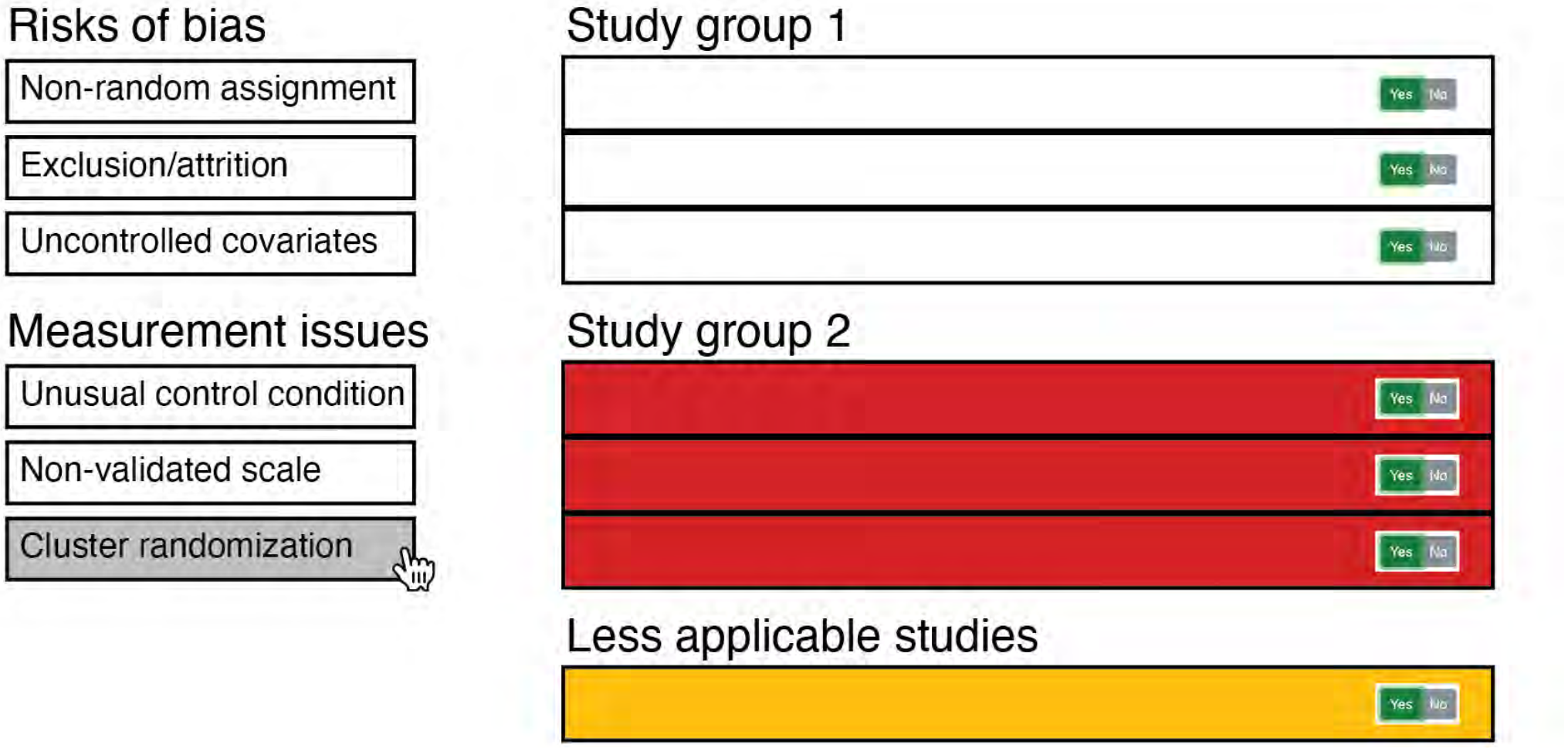
MetaExplorer

Triage view



MetaExplorer

Exploration vs Triage



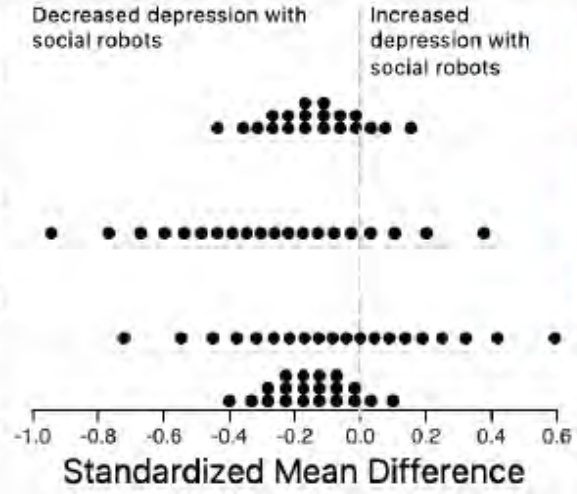
MetaExplorer

Visualization & meta-analysis

Between subjects studies

Switch to Original Units | Sort by Effect Size

Study		Intervention			Control				Effect Size	Include
Author	Timepoint	Mean	SD	N	Mean	SD	N	Weight	Forest Plot	
Robinson et al. 2013	after 12 weeks of treatment	-0.64	3.89	17	0.4	2.56	17	71		Yes No
Tanaka et al. 2012	after 4 weeks of treatment	2.1	2.7	18	3.1	4.2	16	14		Yes No
Tanaka et al. 2012	after 8 weeks of treatment	2.1	2.1	18	2.3	4.1	16	14		Yes No
Average								$I^2 = 0\%$		



MetaExplorer

Visualization & meta-analysis

Note: Study my have failed to isolate intervention effect. Not enough info about participants after exclusions.

Note: Study my have failed to control for baseline depression.

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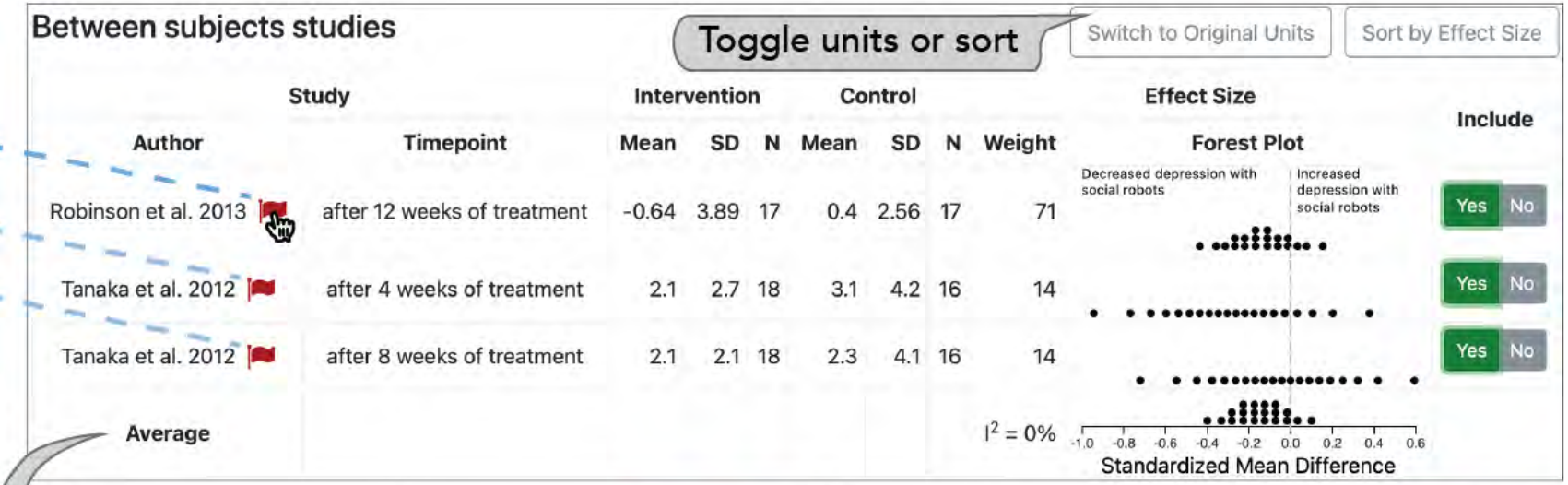
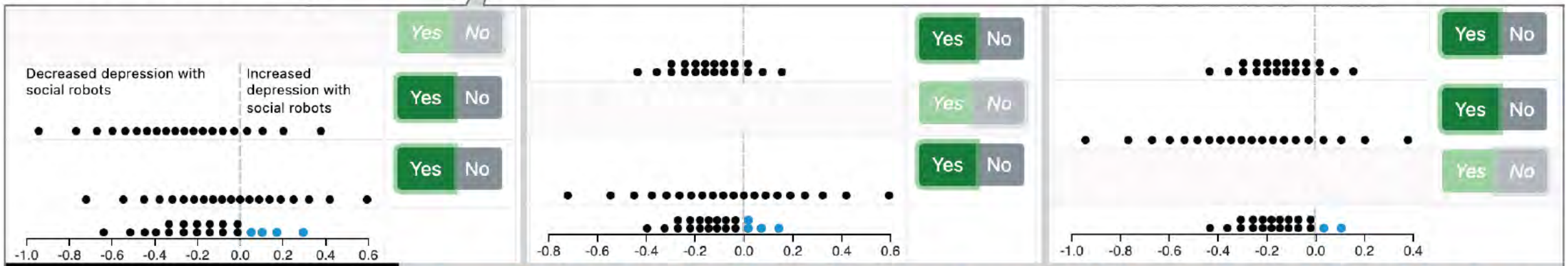
Risk of bias flags





Sensitivity analysis

hypothetical replications showing *increased* depression with social robots

MetaExplorer

Evaluation

Experiments: ground truth is unknown

Case studies: require a huge commitment

Guided tour: hear from experienced meta-analysts

MetaExplorer

Evaluation

Interface as a partner in analysis

“I would model this tool to be a grouchy reviewer that constantly convincing me not to publish the study because I don’t have a corpus that is good enough, or I don’t have enough certainty.” (P09).

MetaExplorer

Evaluation

Interface as a partner in analysis

“Now that I’ve seen this, I really think that needs to be an integral part of a meta-analysis. I have to admit that in meta-analyses I’ve been involved in, these conversations didn’t come up that much. I don’t remember having deep, long conversations about how studies contribute to making policy decisions for particular situations in a particular context.” (P12).

MetaExplorer

Evaluation

Interface as a partner in analysis

Standardization vs customization

“I typically think about [epistemic uncertainty] more manually, less systematically. It comes up all the time, but the tool allows you to have a very strict, very formal way of dealing with it.” (P02).

MetaExplorer

Evaluation

Interface as a partner in analysis

Standardization vs customization

“Would you make this more flexible for people who are in engineering or ecology and evolution? Because our experiments or studies are very much different than social psychology, like a lot of ecology and evolution is observational.” (P05).

Retrospective

Retrospective

Interviews with 11 scientists

4 professors and **1** postdoc @ UW Medical Center

Healthcare economics, sleep & health, STEM education

2 PhDs @ Seattle Veterans Affairs Medical Center

Treatments for PTSD and SUD

4 scientists @ Naval Air Warfare Center Training Systems Division

Trainings for military personnel

Retrospective

Pain points in current practice

Exploration or post-hoc inference

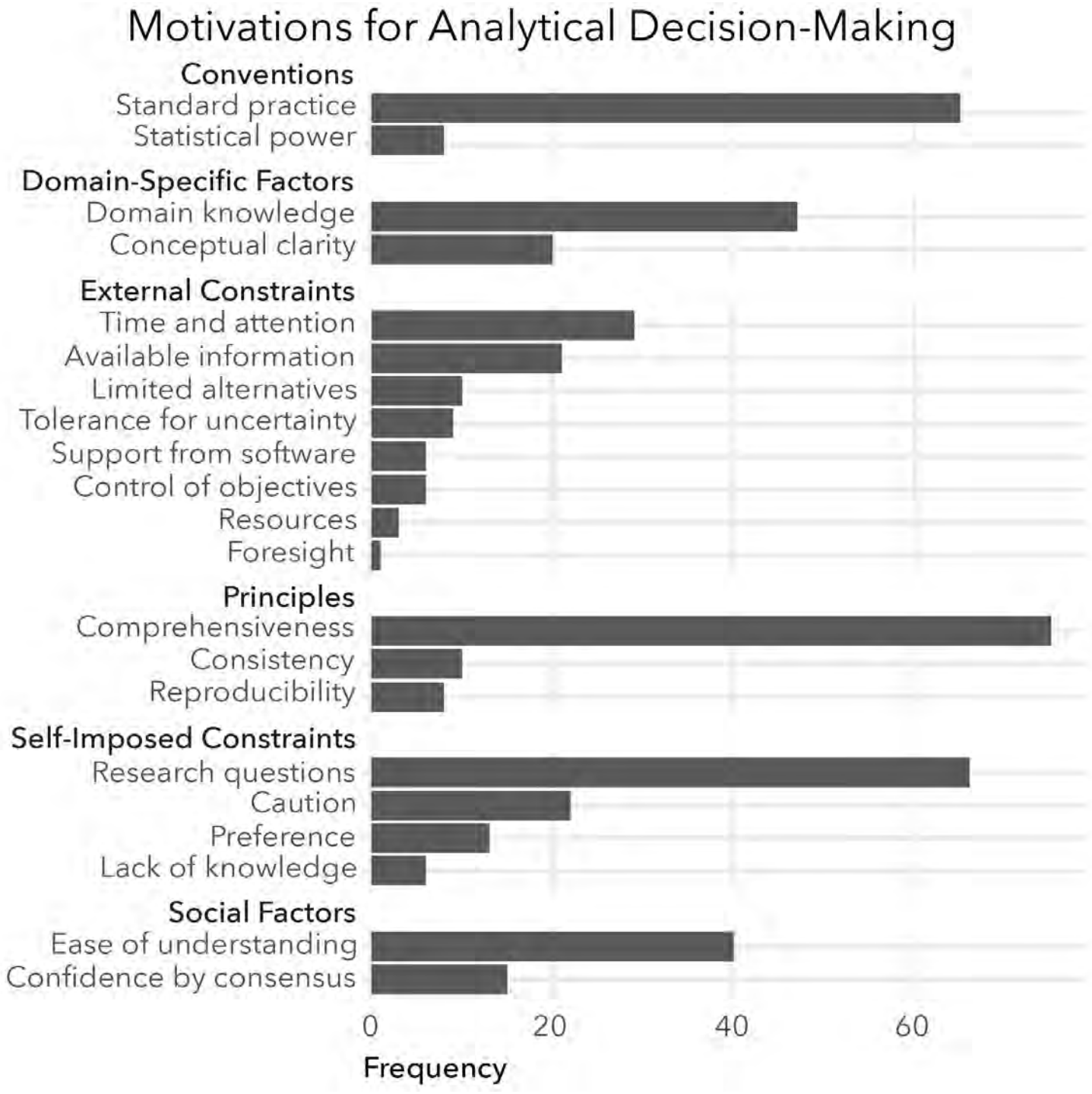
“Through those discussions that we have, we’ll have suggestions for different types of analysis we can conduct that might split the hair a little bit differently and give us additional information that we can then decide, ‘Okay, what is the best way to report this now that we’ve looked at it both of these ways?”’ (P6)

Retrospective

Pain points in current practice

Exploration or post-hoc inference

Decision rationales documented inconsistently


Motivations for Analytical Decision-Making
Conventions
Standard practice
Statistical power
Domain-Specific Factors
Domain knowledge
Conceptual clarity
External Constraints
Time and attention
Available information
Limited alternatives
Tolerance for uncertainty
Support from software
Control of objectives
Resources
Foresight
Principles
Comprehensiveness
Consistency
Reproducibility
Self-Imposed Constraints
Research questions
Caution
Preference
Lack of knowledge
Social Factors
Ease of understanding
Confidence by consensus
0
20
40
60
Frequency

Retrospective

Pain points in current practice

Exploration or post-hoc inference

Decision rationales documented inconsistently

Communicating uncertainty

“They do care about the fidelity of the data, they just don’t want a chart on it.” (P11)

Challenges

Challenges

Communicating uncertainty

Collaboration

Workflow customization

Resolving interacting biases

Sophisticated model specifications

Shades of gray in applicability

Interoperability with other tools

Thanks!

Discussion

What challenges are most important in your work?

How do you want tools to integrate into your workflow?

Alex Kale

AlexKale17

kalealex

kalea@uchicago.edu