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Applications of Open Source and Open Science in Behavior Analysis

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1

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Training Objectives

- Discuss the Open Science Framework (OSF) and the Transparency and Openness Promotion (TOP) guidelines

- Review how the TOP guidelines can be support more open and transparent research in Behavior Analysis

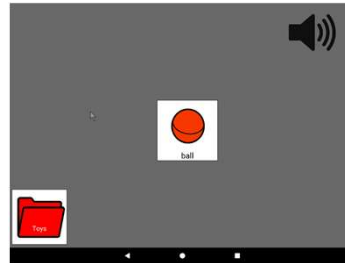- Demonstrate the use of GitHub in archiving elements of Behavior Analytic research

CENTER FOR
OPEN SCIENCE

VIEW THE **BADGES:**
OPEN DATA OPEN MATERIALS PREREGISTERED
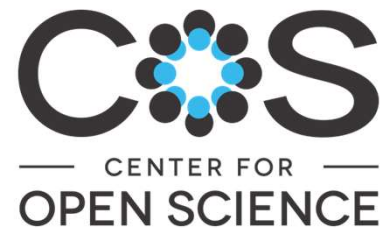
2

Background

- Behavior Analyst
  - Clinical Focus: Autism, developmental disabilities
  - Research Interest: Evaluating interventions for addressing social and communicative deficits

- Programmer, Application Developer
  - Statistical/clinical software
  - Assistive and Augmentative Communication (AAC) software for individuals with social and communicative deficits

Shawn Gilroy
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Edit profile

behavior analyst, school psychologist, programmer. Assistant Professor of Psychology at Louisiana State University. C/C++/C#/R/Python/Jav

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PRO

Organizations

3

Towards a more *Open* form of Science

- Increasing demand for transparent practices in basic and applied research

- A lack of transparency has been linked to the "replication crisis" observed in the behavioral sciences

- The "replication crisis" refers to recent, unsuccessful attempts to replicate the effects reported in earlier research (Open Science Collaboration, 2012, 2015)

4

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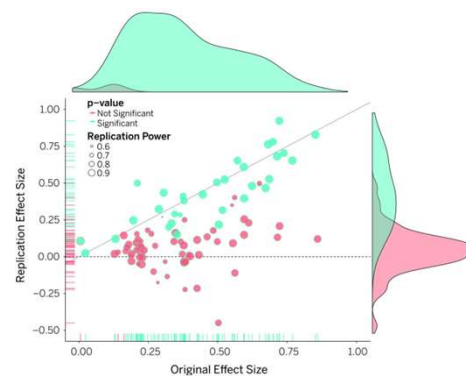
What Prompted the "Crisis" in research?

- Research practices, described as *questionable,* such as:
  - Excluding non-responders to exaggerate the effects of treatments/interventions
  - Using inappropriate testing to produce significant results, e.g. *p hacking*

- Publication practices:
  - Only publishing works with very large effects (i.e., not publishing small, null effects)
  - Biases in publication rates (Sham & Smith, 2014)

- See Nosek et al., (2012) for a broad review

| Questionable Research Practice	Psychology Italy Agnoli et al. [16]	Psychology USA John et al. [17]	Ecology	Evolution
Not reporting response (outcome) variables that failed to reach statistical significance#	47.9 (41.3–54.6)	63.4 (59.1–67.7)	64.1 (59.1–68.9)	63.7 (57.2–69.7)
Collecting more data after inspecting whether the results are statistically significant#	53.2 (46.6–59.7)	55.9 (51.5–60.3)	36.9 (32.4–42.0)	50.7 (43.9–57.6)
Rounding-off a p value or other quantity to meet a pre-specified threshold#	22.2 (16.7–27.7)	22.0 (18.4–25.7)	27.3 (23.1–32.0)	17.5 (13.1–23.0)
Deciding to exclude data points after first checking the impact on statistical significance	39.7 (33.3–46.2)	38.2 (33.9–42.6)	24.0 (19.9–28.6)	23.9 (18.5–30.2)
Reporting an unexpected finding as having been predicted from the start#	37.4 (31.0–43.9)	27.0 (23.1–30.9)	48.5 (43.6–53.6)	54.2 (47.7–60.6)
Filling in missing data points without identifying those data as simulated*	2.3 (0.3–4.2)	0.6 (0.0–1.3)	4.5 (2.8–7.1)	2.0 (0.8–5.1)

#note that these statements began with "in a paper," in John et al. [17] and Agnoli et al [16].
*note that this was referred to as "falsifying data" in John et al. [17] and Agnoli et al [16] which may have influenced the difference in response rates.

https://doi.org/10.1371/journal.pone.0200303.t002

5

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A Crisis for Behavior Analysts?

- Single Case Research (SCR) often includes:
  - Evidence of within-subject replicability
  - Select data regarding response to treatment (i.e., as figures)

- Null Hypothesis Statistical Testing (NHST) contributes to the current "replication crisis" (see Branch, 2018)

- However, NHST is <u>*but one of the factors*</u> associated with questionable research

Figure 4. Multiple Baseline with Embedded Reversals Treatment Evaluation
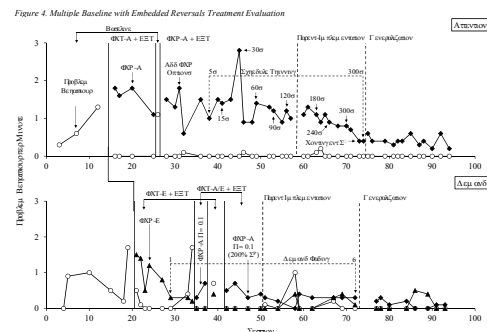
6

A Crisis for Behavior Analysts?

- Similar concerns have been noted in Behavior Analytic venues
  - Sam & Smith (2014)
  - Publication bias have been observed

- Behavior Analytic research can benefit from Open Science as well

JOURNAL OF APPLIED BEHAVIOR ANALYSIS   2014, 47, 663–678   NUMBER 3 (FALL)

PUBLICATION BIAS IN STUDIES OF AN APPLIED BEHAVIOR-ANALYTIC INTERVENTION: AN INITIAL ANALYSIS

ELYSSA SHAM AND TRISTRAM SMITH

UNIVERSITY OF ROCHESTER MEDICAL CENTER

Publication bias arises when studies with favorable results are more likely to be reported than are studies with null findings. If this bias occurs in studies with single-subject experimental designs (SSEDs) on applied behavior-analytic (ABA) interventions, it could lead to exaggerated estimates of intervention effects. Therefore, we conducted an initial test of bias by comparing effect sizes, measured by percentage of nonoverlapping data (PND), in published SSED studies ($n = 21$) and unpublished dissertations ($n = 10$) on 1 well-established intervention for children with autism, pivotal response treatment (PRT). Although published and unpublished studies had similar methodologies, the mean PND in published studies was 22% higher than in unpublished studies, 95% confidence interval (4%, 38%). Even when unpublished studies are included, PRT appeared to be effective (PND $M = 62\%$). Nevertheless, the disparity between published and unpublished studies suggests a need for further assessment of publication bias in the ABA literature.
Key words: publication bias, behavior analysis, single-subject research, autism, pivotal response treatment

7

Transparency and Openness Promotion (TOP)

- TOP guidelines are designed to support desirable scientific practices and behavior
  1. Standards for Citation
  2. *Data Transparency*
  3. *Analytic (Code) Transparency*
  4. *Research Materials Transparency*
  5. Research Design Transparency
  6. Preregistration of Study Designs
  7. Preregistration of Study Analyses
  8. Replication Studies

- We will focus on 2, 3, and 4

Summary of the eight standards and three levels of the TOP guidelines
Levels 1 to 3 are increasingly stringent for each standard. Level 0 offers a comparison that does not meet the standard.

	LEVEL 0	LEVEL 1	LEVEL 2	LEVEL 3
Citation standards	Journal encourages citation of data, code, and materials—or says nothing.	Journal describes citation of data in guidelines to authors with clear rules and examples.	Article provides appropriate citation for data and materials used, consistent with journal's author guidelines.	Article is not published until appropriate citation for data and materials is provided that follows journal's author guidelines.
Data transparency	Journal encourages data sharing—or says nothing.	Article states whether data are available and, if so, where to access them.	Data must be posted to a trusted repository. Exceptions must be identified at article submission.	Data must be posted to a trusted repository, and reported analyses will be reproduced independently before publication.
Analytic methods (code) transparency	Journal encourages code sharing—or says nothing.	Article states whether code is available and, if so, where to access them.	Code must be posted to a trusted repository. Exceptions must be identified at article submission.	Code must be posted to a trusted repository, and reported analyses will be reproduced independently before publication.
Research materials transparency	Journal encourages materials sharing—or says nothing.	Article states whether materials are available and, if so, where to access them.	Materials must be posted to a trusted repository. Exceptions must be identified at article submission.	Materials must be posted to a trusted repository, and reported analyses will be reproduced independently before publication.
Design and analysis transparency	Journal encourages design and analysis transparency or says nothing.	Journal articulates design transparency standards.	Journal requires adherence to design transparency standards for review and publication.	Journal requires and enforces adherence to design transparency standards for review and publication.
Preregistration of studies	Journal says nothing.	Journal encourages preregistration of studies and provides link in article to preregistration if it exists.	Journal encourages preregistration of studies and provides link in article and certification of meeting preregistration badge requirements.	Journal requires preregistration of studies and provides link and badge in article to meeting requirements.
Preregistration of analysis plans	Journal says nothing.	Journal encourages preanalysis plans and provides link in article to registered analysis plan if it exists.	Journal encourages preanalysis plans and provides link in article and certification of meeting registered analysis plan badge requirements.	Journal requires preregistration of studies with analysis plans and provides link and badge in article to meeting requirements.
Replication	Journal discourages submission of replication studies—or says nothing.	Journal encourages submission of replication studies.	Journal encourages submission of replication studies and conducts blind review of results.	Journal uses Registered Reports as a submission option for replication studies with peer review before observing the study outcomes.

8

4

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Accommodating TOP Guidelines in ABA

2. *Data Transparency*
   - Participant data (i.e., all data) can be **public archived**
   - Supports replication as well as research synthesis

3. *Analytic (Code) Transparency*
   - Statistical syntax (i.e., scripts) can be **publicly archived**
   - Supports replication of specific study analyses

4. *Research Materials Transparency*
   - Specific software, surveys, measures can be **publicly archived**
   - Necessary if directly replicating studies at a future time

- Much of the TOP guidelines can be met by archiving files (e.g., GitHub)

GitHub

GitLab

Bitbucket

9

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What is Version Control?

- Version Control (VC) = method of tracking change over time
  - Example: Data set would grow from Experiment 1 → Experiment 2
  - Example: Study materials may change following revision

- VC is particularly suited to scientific applications
  - Others may clone materials and the submit changes *upstream* to the master copy
  - Changes are tracked over time (with timestamps)
  - Contributors/authors are clearly indicated
  - Changes made to the data and materials are clearly documented

- VC is a very transparent way to track research

master

branch   merge

new_feature

time
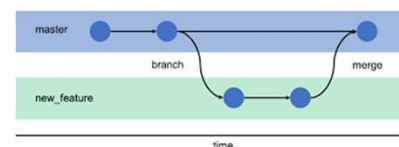
10

What is GitHub?

- GitHub is one of *many* VC tools using the Git protocol (to track changes)

- GitHub is particularly useful because it supports multiple interfaces
  - Command line interface (efficient for programmers like myself)
  - Graphical user interface (supportive for non-programmers; e.g. clinicians)

- GitHub is a robust and accessible way to utilize VC methods
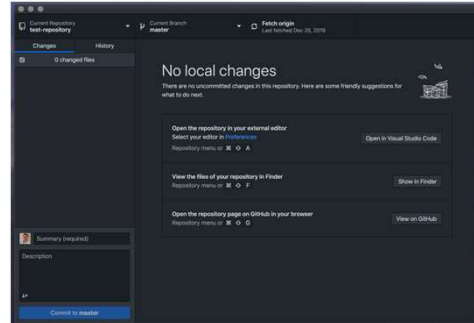
11

Installing GitHub (Desktop)

- GIF OF DOWNLOAD!

12

13

Example #1: Creating Test Repository
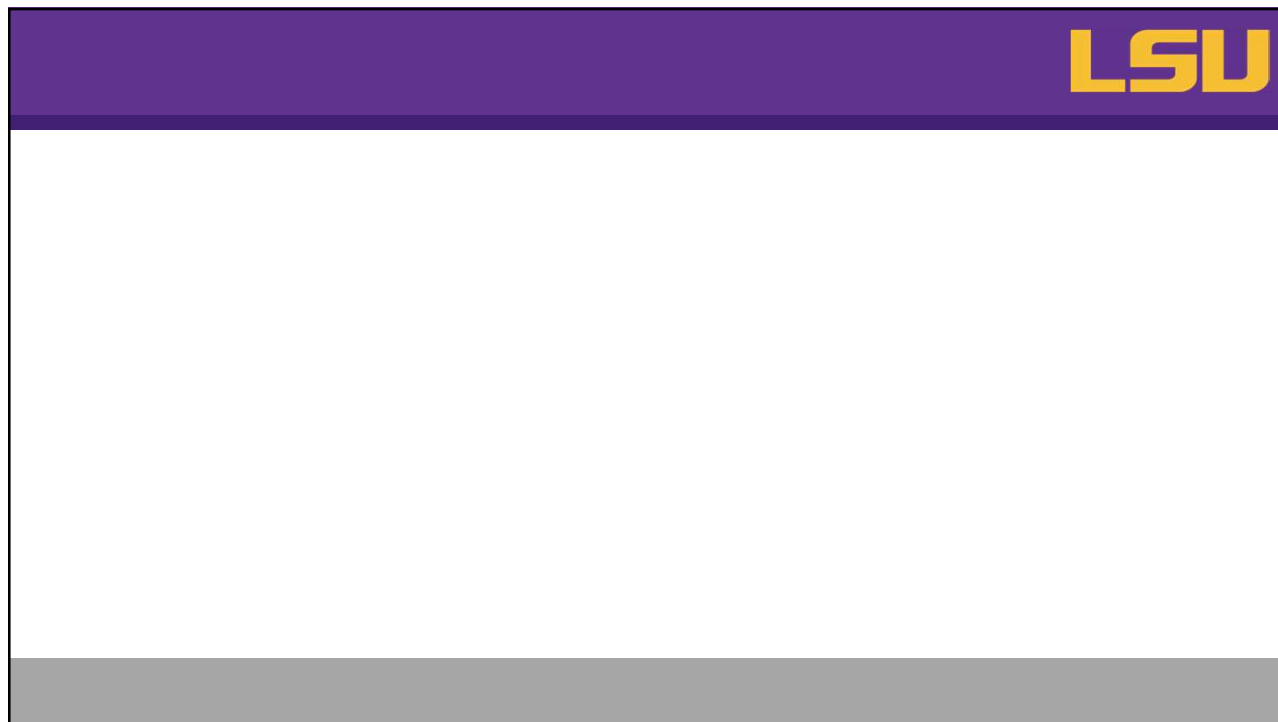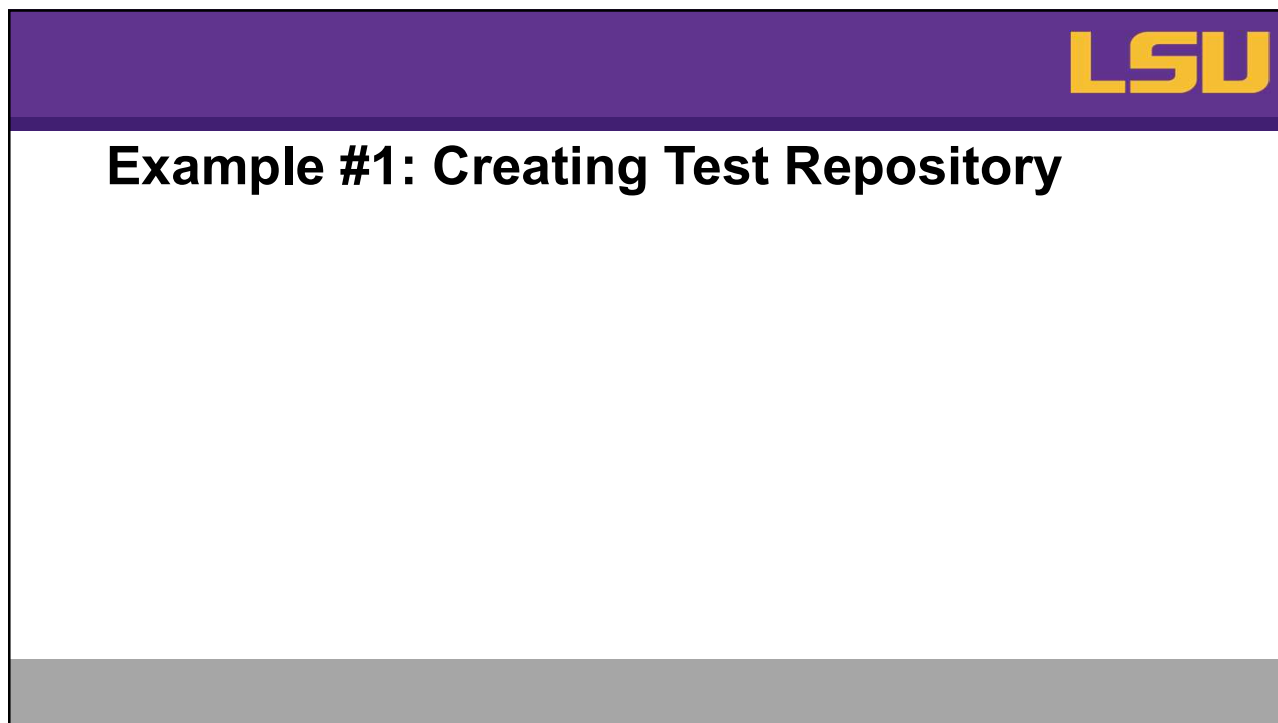
14

Example #1: Creating Test Repository
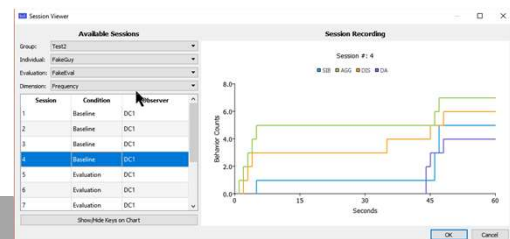
15

16

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Example #2: Retrieving Apps

17

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18

19

Example #3: Retrieving Software

- DataTracker (DT) is a cross platform application (Windows, MacOS, Linux) actively used in several trials

- Similar to BDataPro, but designed for use across more varied systems and languages (international focus)

- https://github.com/miyamot0/DataTracker3

20

Example #3: Building Software

- GIF of download/build

21