

Guidance Source Matters

How Guidance from **AI**, **Expert**, or a **Group of Analysts**
Impacts Visual Data Preparation and Analysis

Guidance Source Matters

How Guidance from **AI**, **Expert**, or a **Group of Analysts**
Impacts Visual Data Preparation and Analysis



arpit narechania



alex endert



atanu sinha

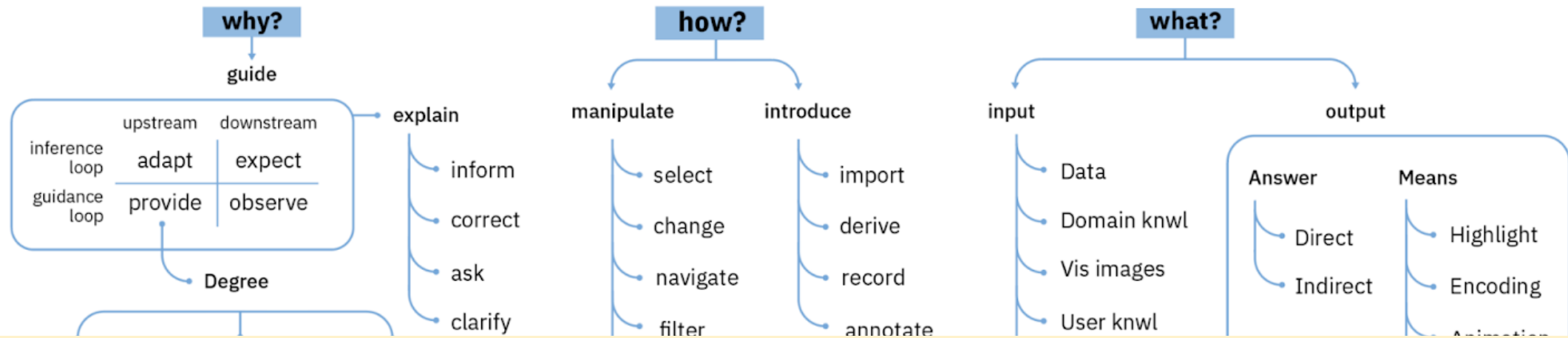
Co-Pilot & AI Assistants strive to provide Guidance!



Human vs. Algorithmic Judgments about Guidance

- **People trust emails less** if they know AI helped write them (Liu et al. 2022).
- **People accept AI recommendations more** than human expert's in ethical decision-making (Tolmeijer et al. 2022).

Typology of Guidance Tasks in Visualization



From whom?

AI Model

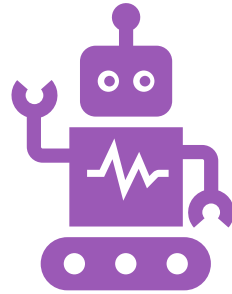
E.g., Small, Medium, Large?

Human(s)

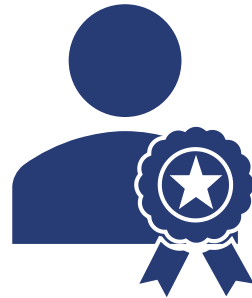
E.g., Expert, Novice, Group?

Research Question

How do users perceive and utilize guidance from different sources?



AI Model

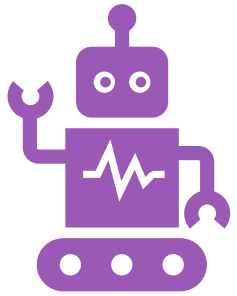


Human Expert



Group of
Human Analysts

Five-conditions Between-subjects Study



AI Model



Human Expert



Group of
Human Analysts



Unattributed



Control

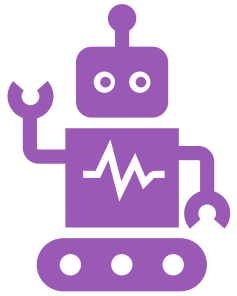
Unattributed Guidance

Guidance is provided without attribution to any source.



Unattributed

Five-conditions Between-subjects Study



AI Model



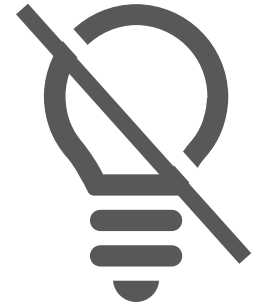
Human Expert



Group of
Human Analysts



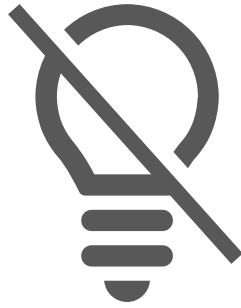
Unattributed



Control

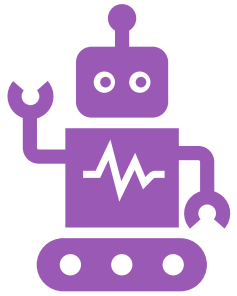
Control (or No Guidance)

Baseline to evaluate the influence of any kind of guidance.



Control

Five-conditions Between-subjects Study



AI Model



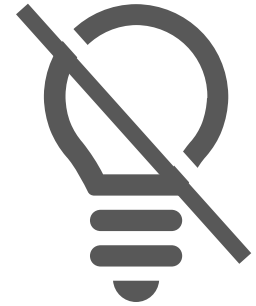
Human Expert



Group of
Human Analysts



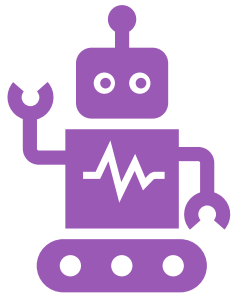
Unattributed



Control

N = 87 participants*

(17)



AI Model

(17)



Human Expert

(17)



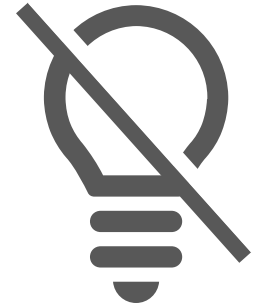
Group of
Human Analysts

(18)



Unattributed

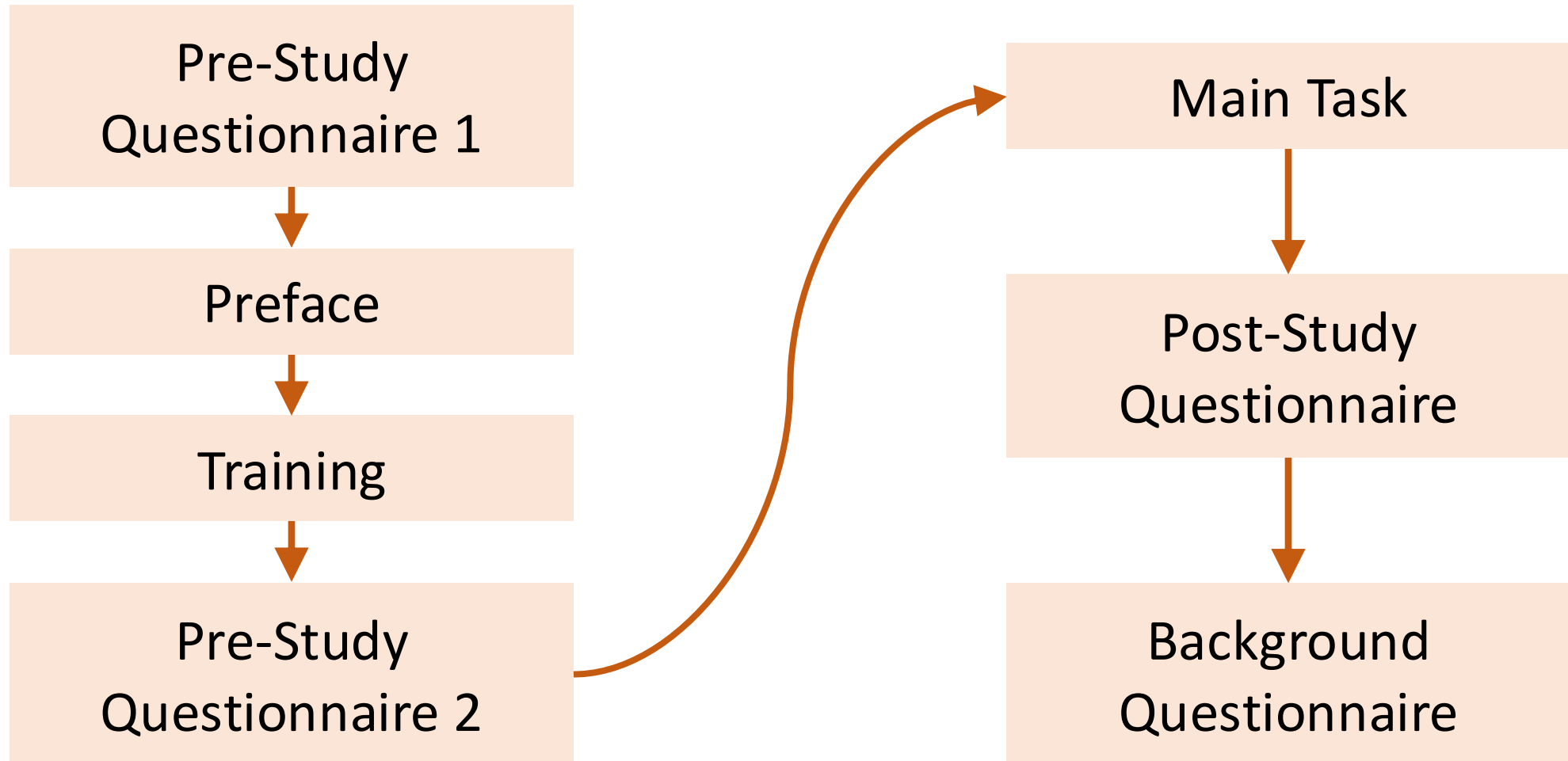
(18)



Control

*3 additional participants completed the study, but their data were discarded

Study Design



Pre-Study
Questionnaire 1

Preface

Training

Pre-Study
Questionnaire 2

Main Task

Post-Study
Questionnaire

Background
Questionnaire

What is your opinion about receiving guidance during analysis tasks?

- Guidance can be **beneficial**

☐ Disagree (1)

☐ 2

☐ 3

☐ 4

☐ 5

☐ 6

☐ Agree (7)

Pre-Study
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Background on AI Usage, e.g.,

- AI has recently performed well on some tasks.
- For other tasks, humans are still superior.

Background on Study Task

- Subset Selection
- Visualization Dashboard Creation

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Priming: Guidance will come from a/an:

- **AI** model trained on large information for data analysis tasks.
- Highly-regarded industry **Expert** in data analysis.
- **Group** of data analysts in your organization well versed in data analysis.

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- **Video demonstration** of the study UI.
- **Practice task** to familiarize with UI.

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What is your opinion about receiving guidance [from AI, Expert, Group, Unattributed] during analysis tasks?

- Guidance **can be reliable**
- Guidance **can increase confidence**
- Guidance **can add value**

☐ Disagree (1)

☐ 2

☐ 3

☐ 4

☐ 5

☐ 6

☐ Agree (7)

Pre-Study
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Instructions



Guidance



UI

- 1. Analyze the dataset** of online customer behavior on an e-commerce website.
- 2. Select 5-15 relevant attributes** indicating meaningful drivers of \$ sales revenue.
- 3. Create and save 3+ visualizations** for examination by your boss.

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Guidance



UI

id	timestamp	name	size	color	price	city	...
1	2018-12-06	shirt	xl	black	35	rome	...
2	2018-12-07	jeans	xxl	blue	109	nice	...
...	...	...	...	...	...	...	...

timestamp	name	price	city
...	...	...	...



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Guidance



UI

- **Non-Control** participants can request guidance.

Ask  AI Model for Guidance



- 1 guidance request = **1 attribute suggestion**.

☐  (A) placecontext.geo.postalcode

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Guidance



UI

- **Maximum 10** guidance requests.
- **7/10** suggestions are always relevant.

This was by design to simulate reality.

Participants do not know we controlled for the Guidance Quality!

Pre-Study
Questionnaire 1

Preface

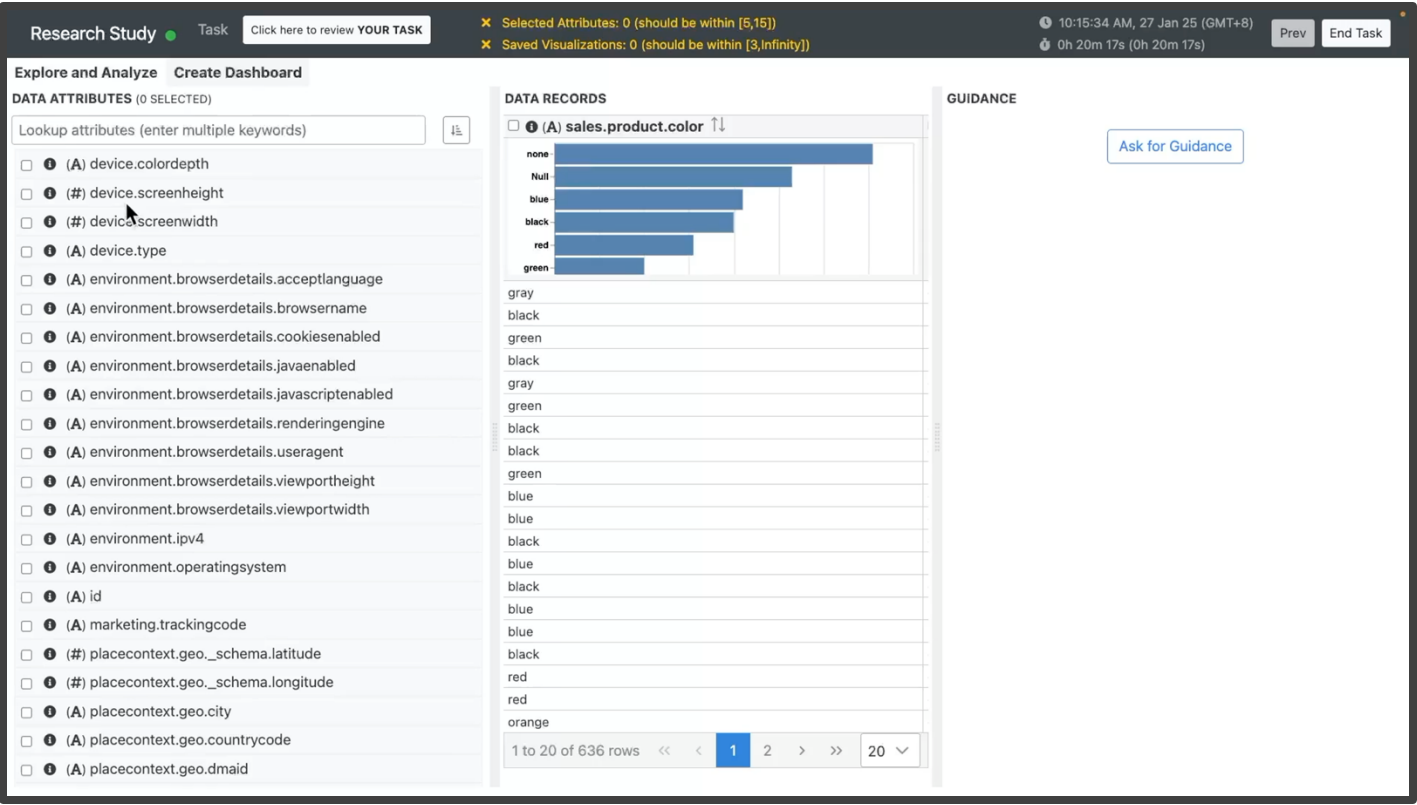
Training

Pre-Study
Questionnaire 2

Main Task

Post-Study
Questionnaire

Background
Questionnaire



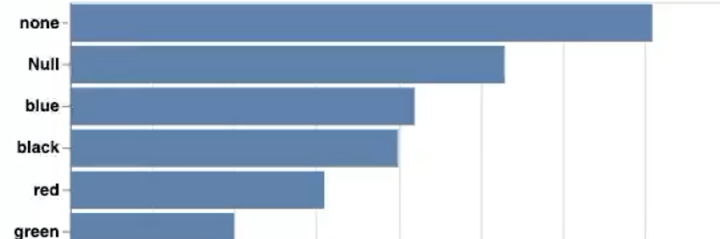
Explore and Analyze **Create Dashboard**

DATA ATTRIBUTES (0 SELECTED)



- ☐ ⓘ (A) device.colordepth
- ☐ ⓘ (#) device.screenheight
- ☐ ⓘ (#) device.screenwidth
- ☐ ⓘ (A) device.type
- ☐ ⓘ (A) environment.browserdetails.acceptlanguage
- ☐ ⓘ (A) environment.browserdetails.browsername
- ☐ ⓘ (A) environment.browserdetails.cookiesenabled
- ☐ ⓘ (A) environment.browserdetails.javaenabled
- ☐ ⓘ (A) environment.browserdetails.javascriptenabled
- ☐ ⓘ (A) environment.browserdetails.renderingengine
- ☐ ⓘ (A) environment.browserdetails.useragent
- ☐ ⓘ (A) environment.browserdetails.viewportheight
- ☐ ⓘ (A) environment.browserdetails.viewportwidth
- ☐ ⓘ (A) environment.ipv4
- ☐ ⓘ (A) environment.operatingsystem
- ☐ ⓘ (A) id
- ☐ ⓘ (A) marketing.trackingcode
- ☐ ⓘ (#) placecontext.geo._schema.latitude
- ☐ ⓘ (#) placecontext.geo._schema.longitude
- ☐ ⓘ (A) placecontext.geo.city
- ☐ ⓘ (A) placecontext.geo.countrycode
- ☐ ⓘ (A) placecontext.geo.dmaid

DATA RECORDS

☐ ⓘ (A) sales.product.color ↑↓

gray

black

green

black

gray

green

black

black

green

blue

blue

black

blue

black

blue

blue

black

red

red

orange

1 to 20 of 636 rows << < 1 2 > >> 20 ▾

GUIDANCE

[Ask for Guidance](#)

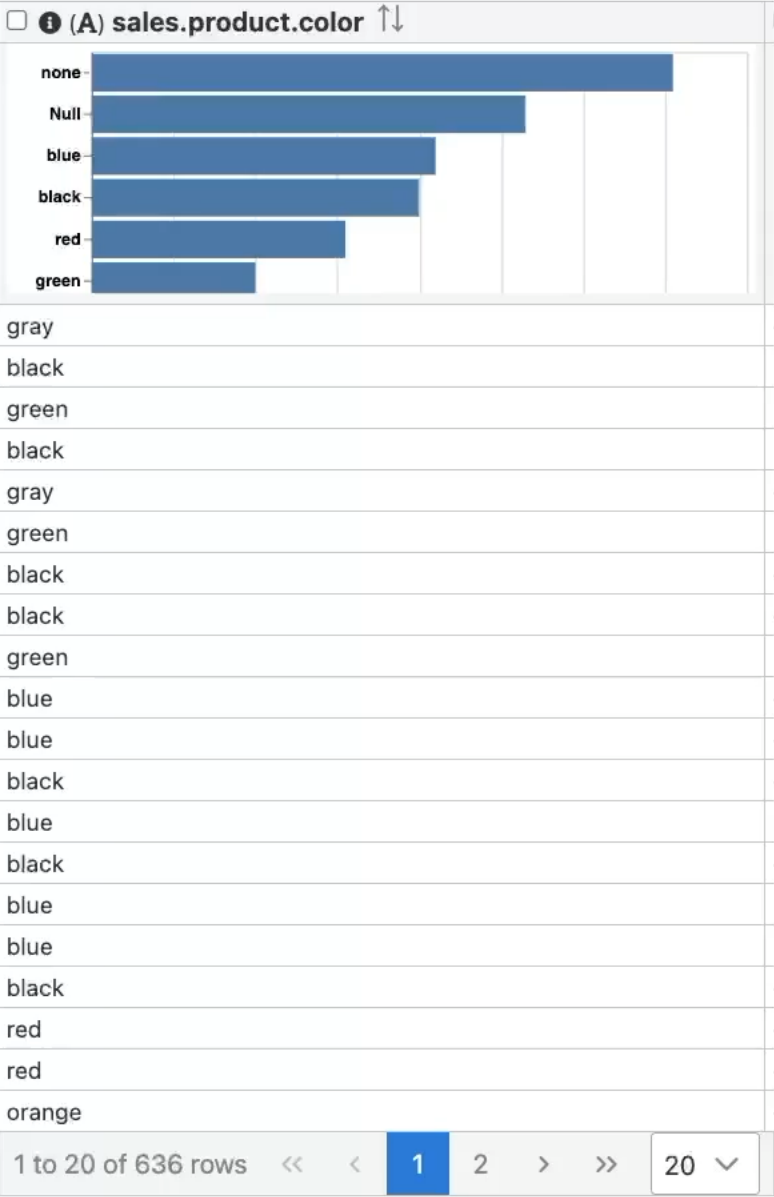
Explore and Analyze Create Dashboard

DATA ATTRIBUTES (0 SELECTED)

Lookup attributes (enter multiple keywords)

- ☐ ⓘ (A) device.colordepth
- ☐ ⓘ (#) device.screenheight
- ☐ ⓘ (#) device.screenwidth
- ☐ ⓘ (A) device.type
- ☐ ⓘ (A) environment.browserdetails.acceptlanguage
- ☐ ⓘ (A) environment.browserdetails.browsername
- ☐ ⓘ (A) environment.browserdetails.cookiesenabled
- ☐ ⓘ (A) environment.browserdetails.javaenabled
- ☐ ⓘ (A) environment.browserdetails.javascriptenabled
- ☐ ⓘ (A) environment.browserdetails.renderingengine
- ☐ ⓘ (A) environment.browserdetails.useragent
- ☐ ⓘ (A) environment.browserdetails.viewportheight
- ☐ ⓘ (A) environment.browserdetails.viewportwidth
- ☐ ⓘ (A) environment.ipv4
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- ☐ ⓘ (#) placecontext.geo._schema.latitude
- ☐ ⓘ (#) placecontext.geo._schema.longitude
- ☐ ⓘ (A) placecontext.geo.city
- ☐ ⓘ (A) placecontext.geo.countrycode
- ☐ ⓘ (A) placecontext.geo.dmaid

DATA RECORDS



GUIDANCE

Ask for Guidance

Explore and Analyze **Create Dashboard**

DATA ATTRIBUTES (10 SELECTED)

- Lookup attributes (enter multiple keywords)
- ☐

i

(A)

device.colordepth
- ☐

i

(#)

device.screenheight
- ☐

i

(#)

device.screenwidth
- ☒

i

(A)

device.type
- ☐

i

(A)

environment.browserdetails.acceptlanguage
- ☒

i

(A)

environment.browserdetails.browsername
- ☐

i

(A)

environment.browserdetails.cookiesenabled
- ☐

i

(A)

environment.browserdetails.javaenabled
- ☐

i

(A)

environment.browserdetails.javascriptenabled
- ☐

i

(A)

environment.browserdetails.renderingengine
- ☐

i

(A)

environment.browserdetails.useragent
- ☐

i

(A)

environment.browserdetails.viewportheight
- ☐

i

(A)

environment.browserdetails.viewportwidth
- ☐

i

(A)

environment.ipv4
- ☒

i

(A)

environment.operatingsystem
- ☐

i

(A)

id
- ☒

i

(A)

marketing.trackingcode
- ☐

i

(#)

placecontext.geo._schema.latitude
- ☐

i

(#)

placecontext.geo._schema.longitude
- ☒

i

(A)

placecontext.geo.city
- ☒

i

(A)

placecontext.geo.countrycode
- ☐

i

(A)

placecontext.geo.dmaid

DATA RECORDS

☒ **i** (A) environment.browserdetails.browsername ↕

Browser	# Datapoints
Chrome	390
Unknown	150
Safari	80
Firefox	10

Chrome
Chrome
Chrome
Chrome
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Chrome

1 to 20 of 636 rows << < 1 2 > >> 20 ▾

GUIDANCE

Ask for Guidance

Explore and Analyze Create Dashboard

SELECTED DATA ATTRIBUTES (10 SELECTED)

- ☒ ⓘ (A) device.type
- ☒ ⓘ (A) environment.browserdetails.browsername
- ☒ ⓘ (A) environment.operatingsystem
- ☒ ⓘ (A) marketing.trackingcode
- ☒ ⓘ (A) placecontext.geo.city
- ☒ ⓘ (A) placecontext.geo.countrycode
- ☒ ⓘ (A) sales.product.name
- ☒ ⓘ (A) sales.purchase.timestamp
- ☒ ⓘ (#) sales.purchases.price
- ☒ ⓘ (A) session.search.searchengine

MARK

bar

x

ENCODINGS

Swap xy

x

- ⓘ x x
- ⓘ y x
- ⓘ fill x
- ⓘ x
- stroke
- ⓘ size x
- ⓘ x

SAVED VISUALIZATIONS (1 SAVED)

🗑

Attributes in saved vis can't be deselected.

Average Revenue across Marketing Campaigns

🗑

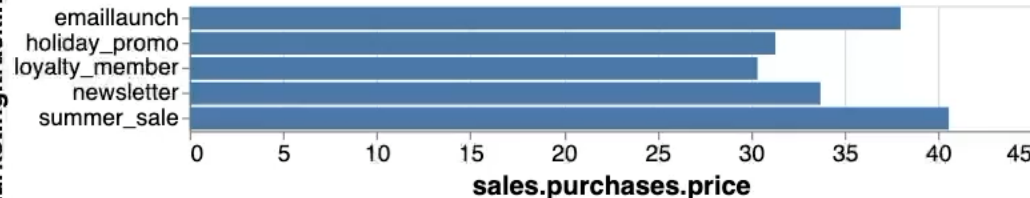


VISUALIZATION

Enter Name to Save

🗑

marketing.trackingcode



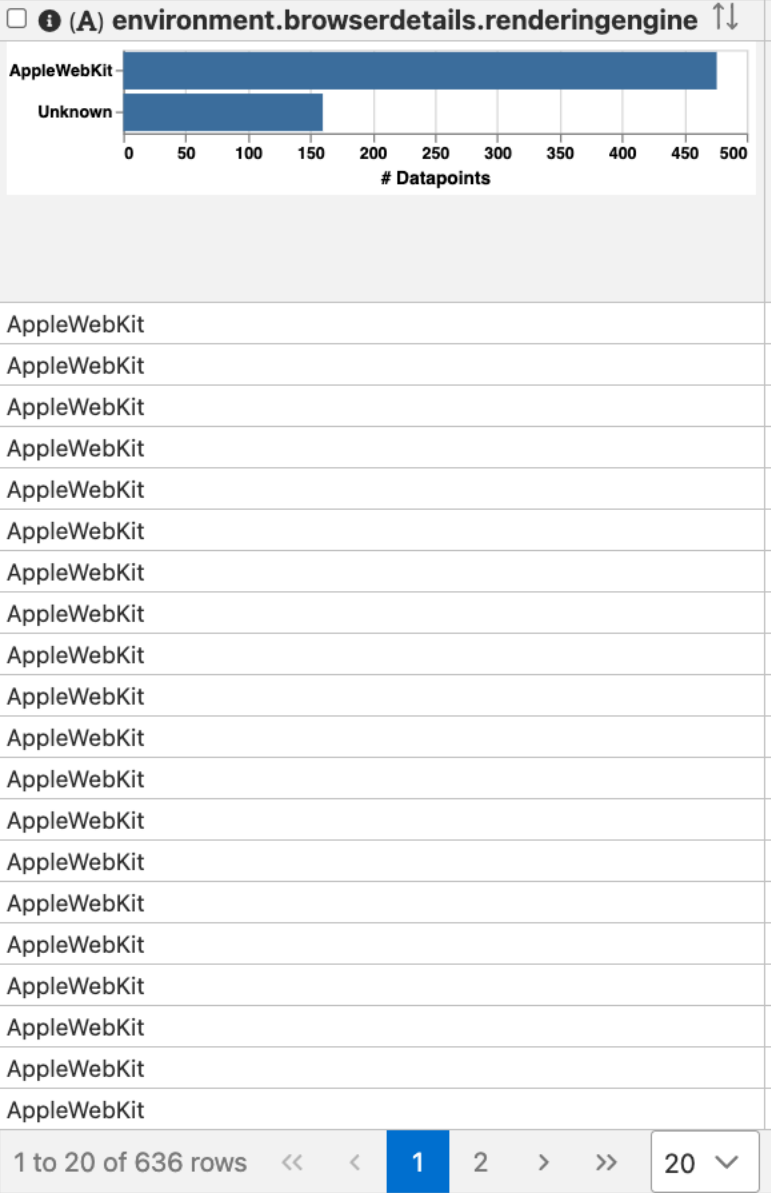
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- ☒ ⓘ (A) device.type
- ☐ ⓘ (A) environment.browserdetails.acceptlanguage
- ☒ ⓘ (A) environment.browserdetails.browsername
- ☐ ⓘ (A) environment.browserdetails.cookiesenabled
- ☐ ⓘ (A) environment.browserdetails.javaenabled
- ☐ ⓘ (A) environment.browserdetails.javascriptenabled
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- ☐ ⓘ (A) environment.browserdetails.viewportheight
- ☐ ⓘ (A) environment.browserdetails.viewportwidth
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- ☒ ⓘ (A) environment.operatingsystem
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- ☒ ⓘ (A) placecontext.geo.city
- ☒ ⓘ (A) placecontext.geo.countrycode
- ☐ ⓘ (A) placecontext.geo.dmaid

DATA RECORDS



GUIDANCE

- ☐ ⓘ (A) placecontext.geo.postalcode
- ☒ ⓘ (A) placecontext.geo.city
- ☐ ⓘ (A) environment.browserdetails.renderingengine
- ☒ ⓘ (A) marketing.trackingcode

[Ask for Guidance](#)

[Ask 🧑 Human Expert Analyst for Guidance](#) ?

[Ask 👥 Group of Data Analysts for Guidance](#) ?

[Ask 🤖 AI Model for Guidance](#) ?

?

Pre-Study
Questionnaire 1

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Main Task

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Background
Questionnaire

Participants' Views about Guidance

- Guidance **was reliable**
- Guidance **increased confidence**
- Guidance **added value**

☐ Disagree (1)

☐ 2

☐ 3

☐ 4

☐ 5

☐ 6

☐ Agree (7)

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Participants' Views about Guidance

- How much did you **rely** on guidance?
- How much did you **regret** using guidance?

- ☐ 1 (Not at all)
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5
- ☐ 6
- ☐ 7 (A lot)

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Participant Demographics

- Age
- Gender
- Highest Level of Education
- Major

Hypotheses Driven Analysis and Testing

Preregistered on OSF: osf.io/q6ca5

H1

H2

H3

Source-agnostic

Unattributed vs **Control**

H4

H5

Source-specific

AI vs **Expert** vs **Group of Analysts**

H1

Hypothesis

Participants who receive guidance (**Unattributed**) will be less uncertain about their attribute selections.

H2

Metric

Uncertainty → Variance in # Interactions with attributes.

H3

Result (M = median)

Unattributed (M=19.18) < **Control** (M=21.82)

Not statistically significant (p=0.34)
as per one-sided Mann-Whitney U test.

H4

H5

H1

H2

Hypothesis

Participants who receive guidance (**Unattributed**) will select more attributes.

H3

Result

Unattributed (M=10.5) > **Control** (M=6.0)

Statistically significant (p=0.001)
as per one-sided Mann-Whitney U test.

H4

H5

H1

H2

Metric

Verification → # Interactions with guided attributes before and after guidance

Result

AI (M=31) > **Expert** (M=14) > **Group** (M=12.5)

AI <> **Group** is statistically significant ($p=0.003$),
as per pairwise one-sided Mann Whitney U test with Bonferroni correction

H3

H4

Hypothesis

Participants will verify the guidance more
when it comes from **AI** > **Expert** > **Group**

H5

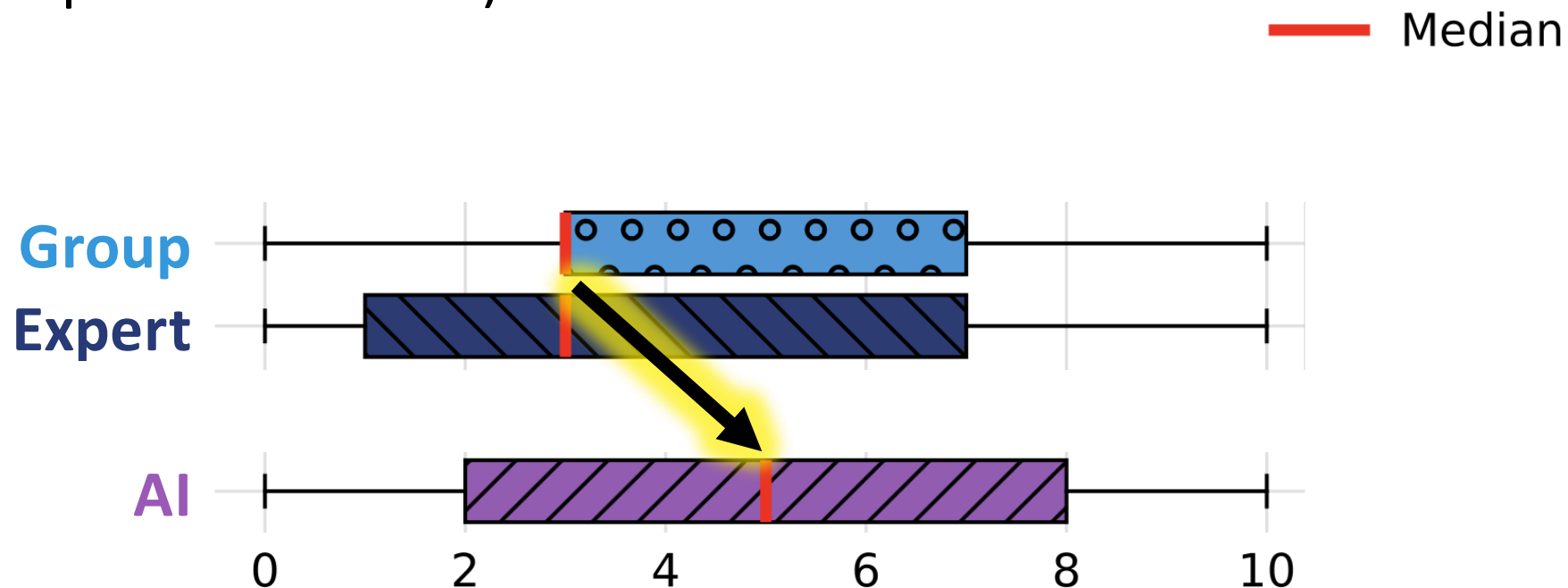
Key Takeaways

1. Guidance Source Matters in people's utilization of guidance during analysis.

Behavioral Analyses

Exploitation of Guidance Availability

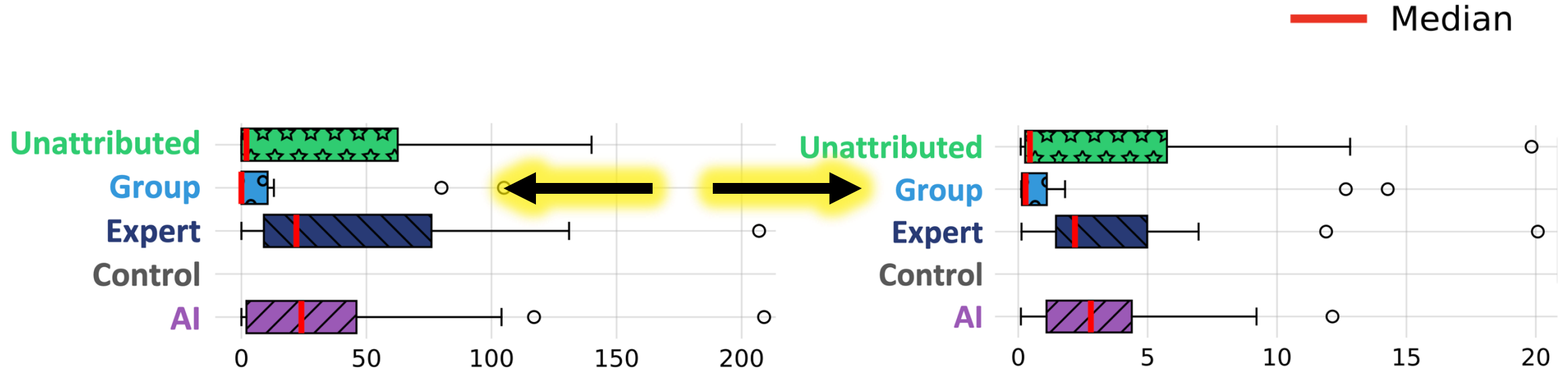
(# Guidance Requests out of 10)



Among attributed sources, is there a general belief around **AI** to be more salient?

Eagerness to Access Guidance

(# Interactions & Time in minutes until 1st Guidance Request)



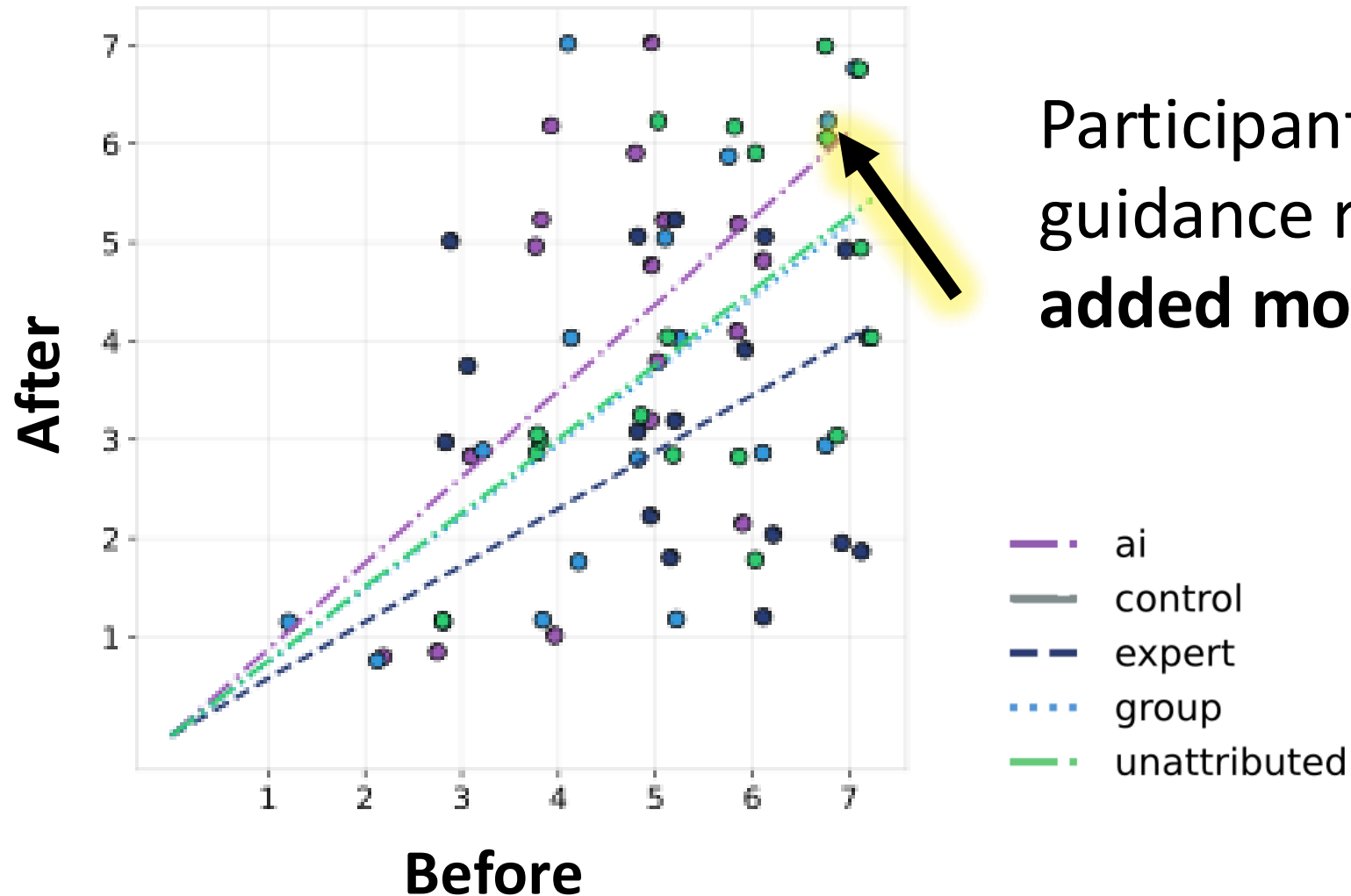
Is this because the stored knowledge from **Group** is psychologically more accessible than **AI**, **Expert**?

Key Takeaways

1. Guidance Source Matters in people's utilization of guidance during analysis.
2. Participants utilize guidance differently at various stages of analysis.

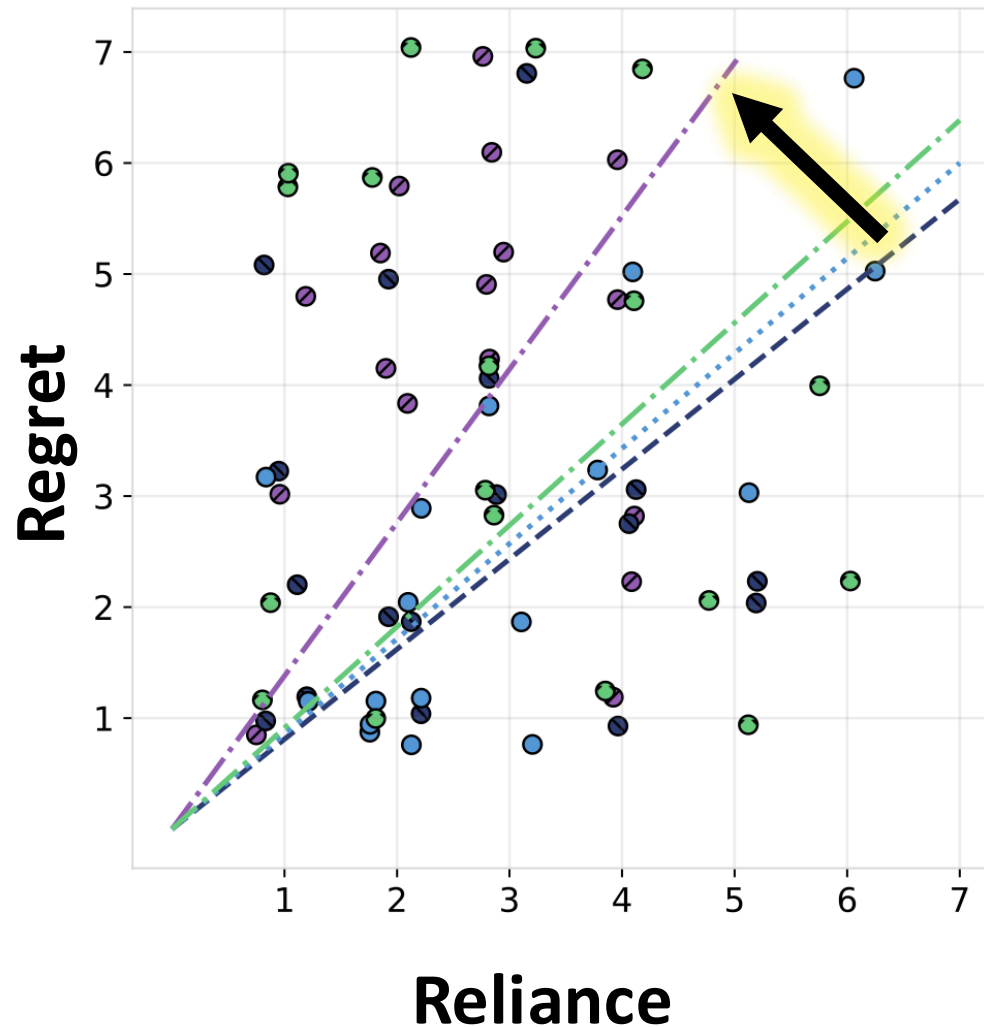
Analyses of Self-Reported Participant Responses in the Questionnaires

Guidance Can Add Value (**Before**) vs Added Value (**After**)



Participants receiving **AI** guidance reported it **added most value.**

Reliance on vs. Regret after using Guidance



Participants receiving **AI** guidance reported **highest regret!**



Key Takeaways

1. Guidance Source Matters in people's utilization of guidance during analysis.
2. Participants utilize guidance differently at various stages of analysis.
3. Participants receiving **AI** guidance reported both higher post-task benefit as well as regret.

Key Takeaways

1. Guidance Source Matters in people's utilization of guidance during analysis.
2. Participants utilize guidance differently at various stages of analysis.
3. Participants receiving **AI** guidance reported both higher post-task benefit as well as regret.

Limitations

- Attribute selection task was **somewhat subjective**.
- **No explanations** behind the provided guidance.

Future Work

- Study **factors** contributing to **regret** during guidance utilization.
- Study **how user expertise** impacts guidance utilization.

Guidance Source Matters

How Guidance from **AI**, **Expert**, or a **Group of Analysts**
Impacts Visual Data Preparation and Analysis



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