Scientific Observation of Behaviour

Lecture 02 (Modelling I)

Alessandro Vinciarelli

Outline

- The 11 Steps of Behaviour Observation
- Example: Dyadic Conversations over the Phone
- Conclusions

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- Conclusions

Ask a Question

"Before any scientific problem is investigated, some sort of question will have been formulated […] may initially be a broad one […] Such a question is not a hypothesis."

Martin & Bateson, "Measuring Behaviour", Cambridge University Press, 2007 (Chapter 3)

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Make Preliminary Observations

"A period of preliminary observation is generally invaluable in deciding what measurements to make and should be regarded as crucial part of any study."

Martin & Bateson, "Measuring Behaviour", Cambridge University Press, 2007 (Chapter 3)

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Identify the Variables

"The form of the research and the variables that are to be measured should then be chosen as to provide the best account of what you have observed."

Martin & Bateson, "Measuring Behaviour", Cambridge University Press, 2007 (Chapter 3)

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Choose Suitable Sensors

"No observer can record behaviour without selecting some features […] and ignoring others. The selection […] reflects the questions you asked at the beginning of the study."

Martin & Bateson, "Measuring Behaviour", Cambridge University Press, 2007 (Chapter 3)

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Collect and Analyse Data

"[…] plan in advance how much data you will need to collect in order to obtain a clear conclusion […] Use the appropriate statistical tools to for analysing the data."

Martin & Bateson, "Measuring Behaviour", Cambridge University Press, 2007 (Chapter 3)

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Formulate Precise Hypothesis

"A clear hypothesis invites a direct test […] hypotheses may be tested by observing natural variation in a population as well as by performing experiments."

Martin & Bateson, "Measuring Behaviour", Cambridge University Press, 2007 (Chapter 3)

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Make Predictions

"A clear hypothesis should, by a process of straightforward reasoning, give rise to one or more specific predictions that can be tested empirically."

Martin & Bateson, "Measuring Behaviour", Cambridge University Press, 2007 (Chapter 3)

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Design the Tests

"The variables that are to be measured should then be chosen so as to provide the best test of the different predictions made by competing hypotheses."

Martin & Bateson, "Measuring Behaviour", Cambridge University Press, 2007 (Chapter 3)

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Test Your Hypotheses

"Use the same measurement procedures throughout and try, if possible, to collect data 'blind' so that you do not unconsciously select data that fit your hypothesis."

Martin & Bateson, "Measuring Behaviour", Cambridge University Press, 2007 (Chapter 3)

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Analyse the Results

"Employ the appropriate statistical tools, both for presenting and exploring the data, and for testing the hypotheses."

Martin & Bateson, "Measuring Behaviour", Cambridge University Press, 2007 (Chapter 3)

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Consider Alternative Interpretations

"Do not draw more conclusions than the data support, but do try to formulate a list of questions and ideas suggested by the data that could form the basis of future research."

Martin & Bateson, "Measuring Behaviour", Cambridge University Press, 2007 (Chapter 3)

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The Data (Phone Calls)

Number of Calls	60
Number of Subjects	120
Total Length	11h : 48m : 24s
Average Length	11m : 48s
Audio Sampling Frequency	44kHz
Gyroscopes Sampling	68Hz
Psychometric Questionnaires	2
Total Annotated Cues	16,235

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Scenario

- All dyads are formed of unacquainted speakers;
- The scenario is based on the Winter Survival Task, a collaborative negotiation and decision-making exercise (used by NASA);
- Social dynamics dominate the conversation because most people lack expertise in survival techniques;
- The Corpus is gender balanced (63 female vs 57 male), the gender composition is distributed uniformly (half same-gender and half different-gender).

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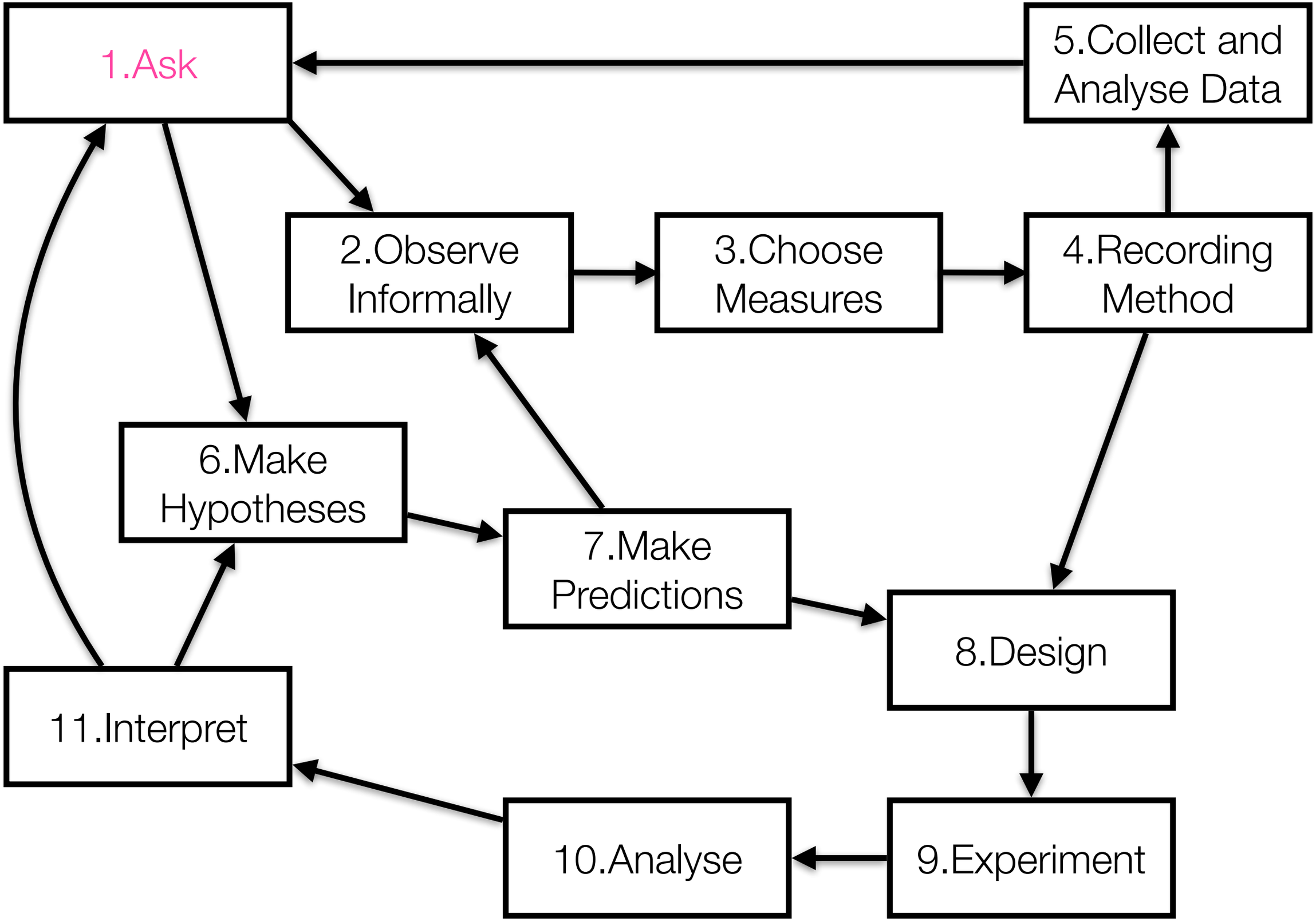

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Ask a Question

Do people use nonverbal communication in phone calls and, if yes, how?

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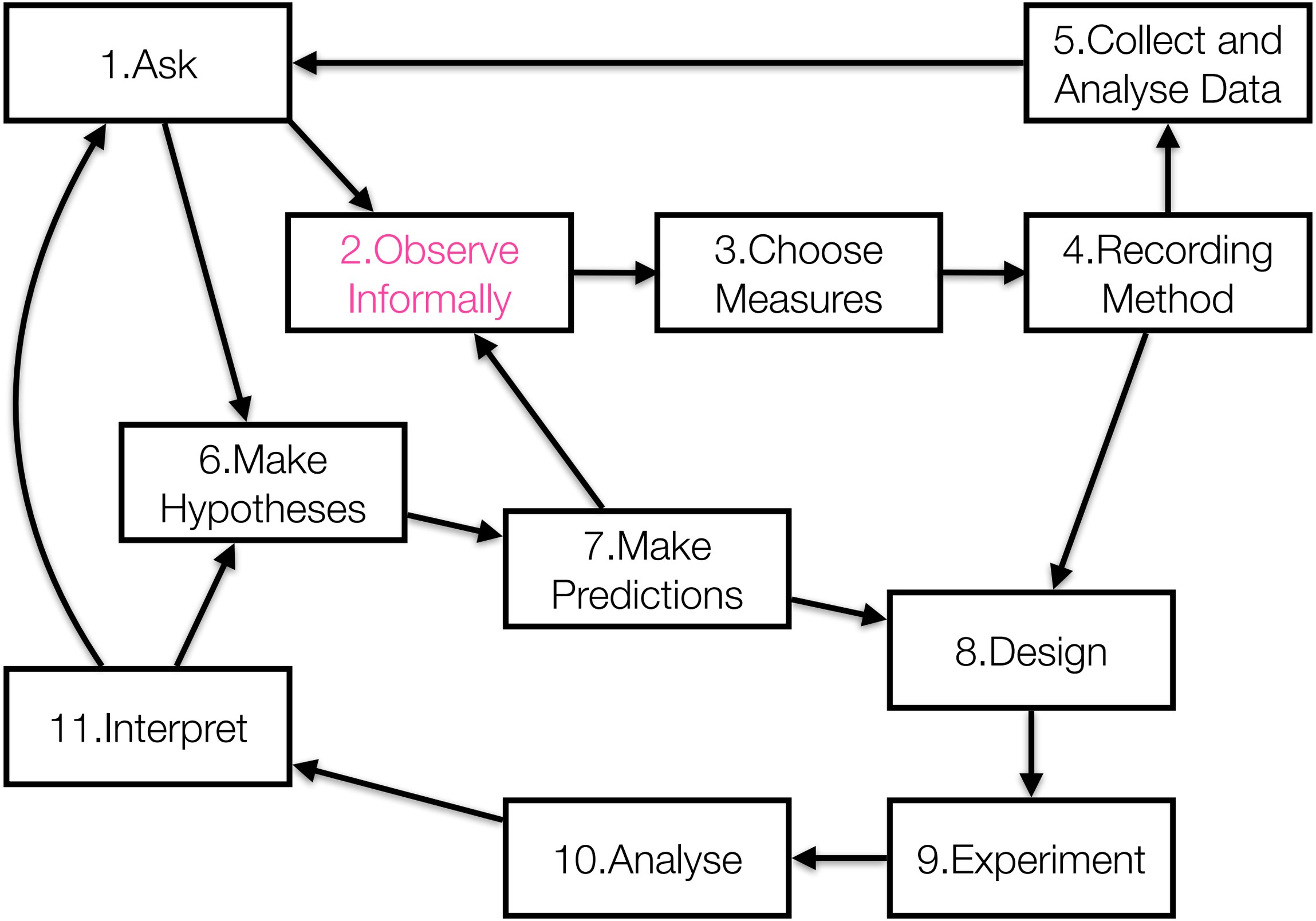

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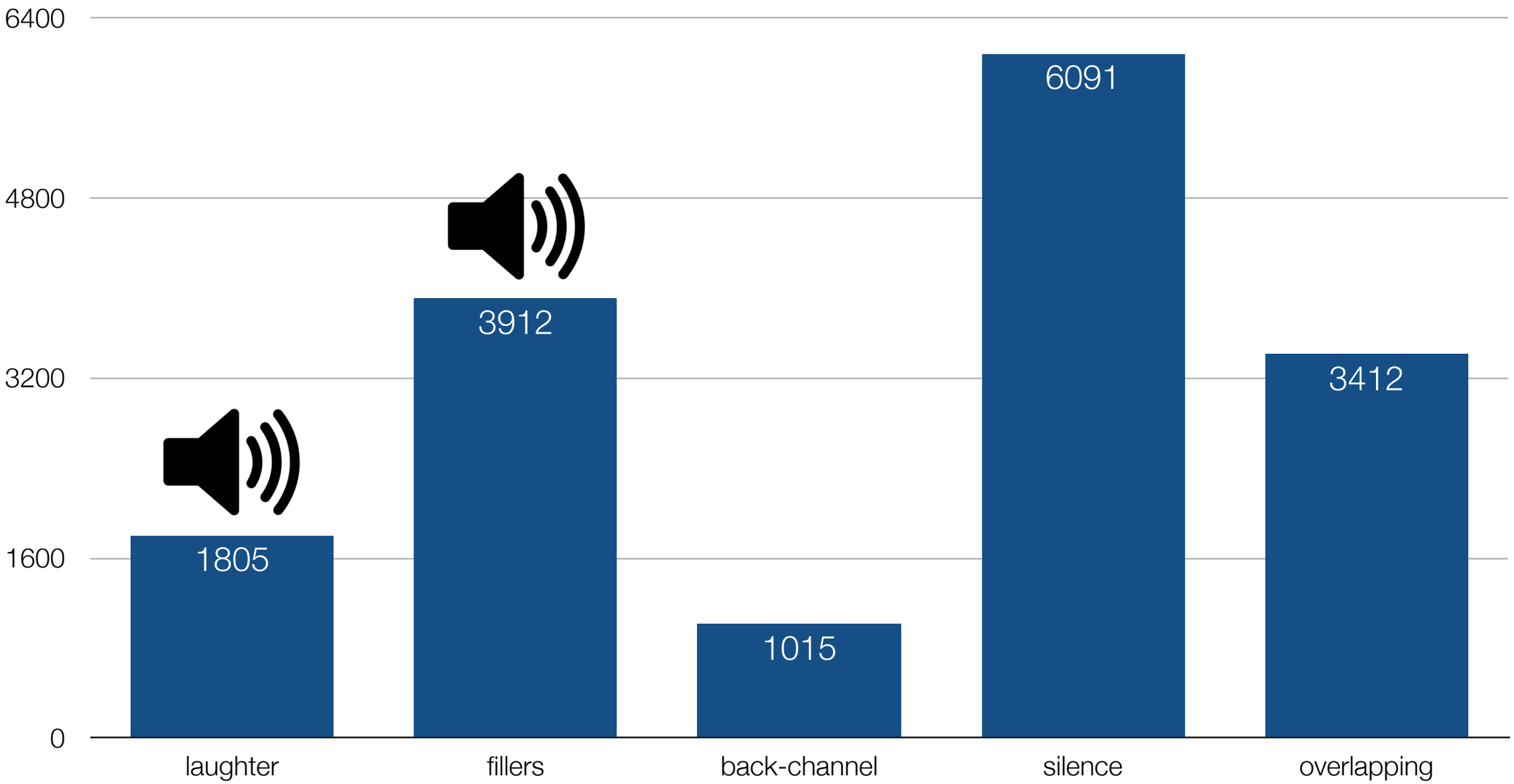
Make Preliminary Observations (I)



Vinciarelli, Chatziioannou & Esposito,"When Words are Not Everything: the use of laughter, fillers, back-channel, silence, and overlapping speech in phone calls", Frontiers in ICT, 2(4), 2015.

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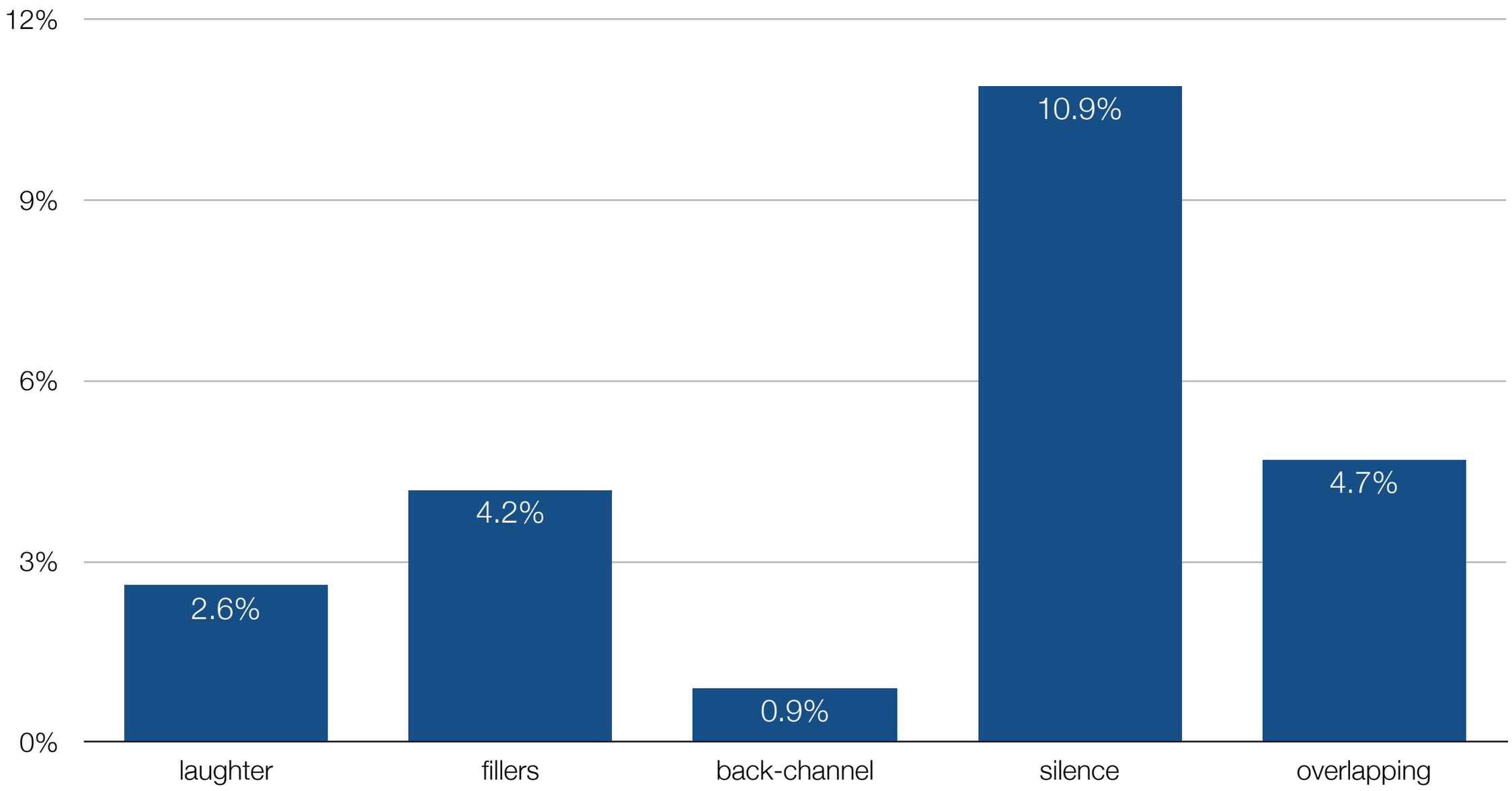
Make Preliminary Observations (II)



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Key-Findings

- The total number of observed cues is 16,235;
- The total percentage of time spent in nonverbal communication is 23.3%;
- The figures suggest that people use nonverbal communication to a substantial extent;
- The question posed at the beginning makes sense for the data and, in turn, the data provides enough evidence to address the question.

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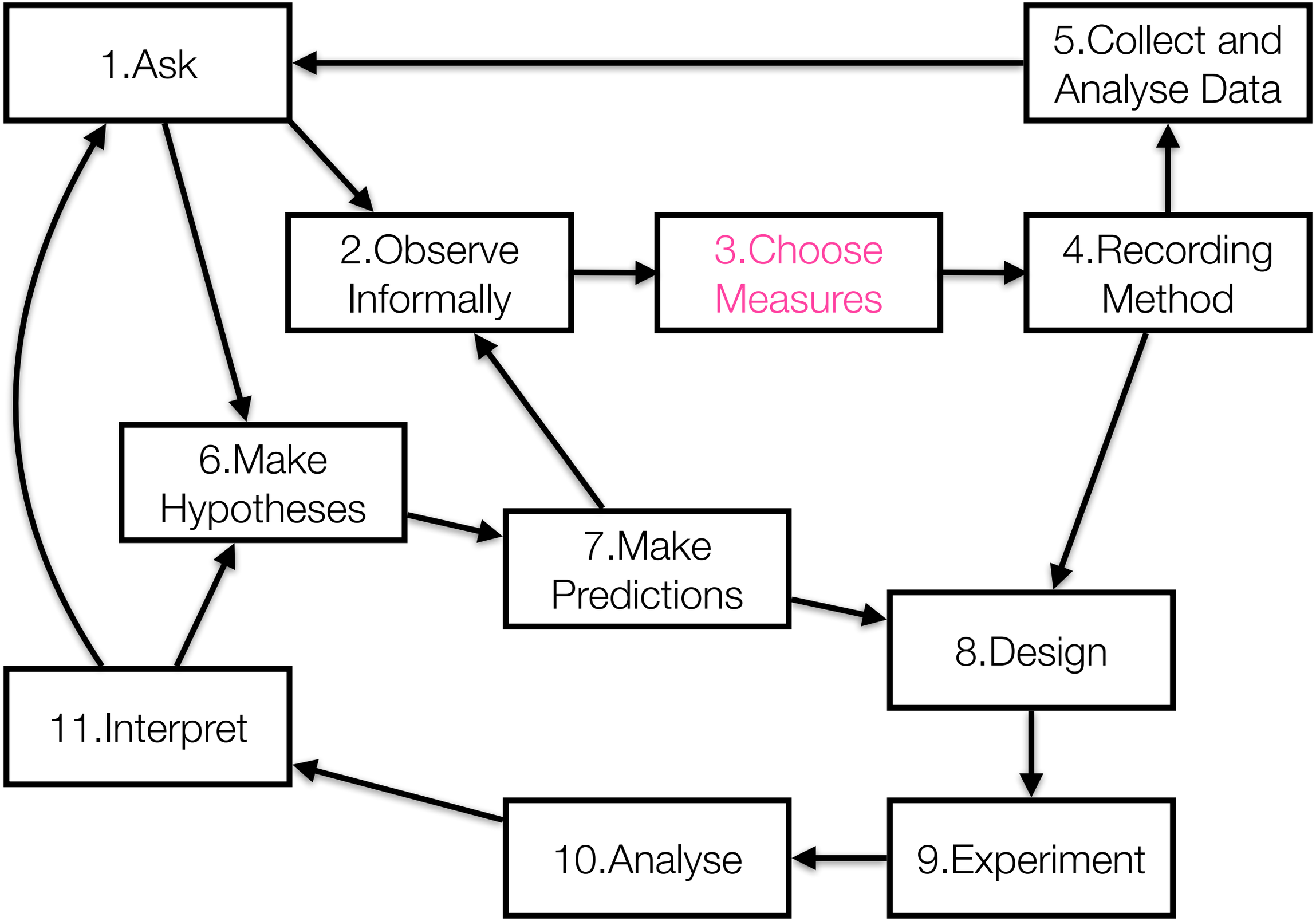

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Identify the Variables

- Number of occurrences of nonverbal cues (laughter, filler, backchannel, silence, overlapping) for different types of speakers (female and male, caller and receiver);
- Gender (female or male) and Role (caller or receiver) are two major sociological variables;
- Association between gender and role on one side and, on the other side, number of occurrences can explain how people use nonverbal communication.

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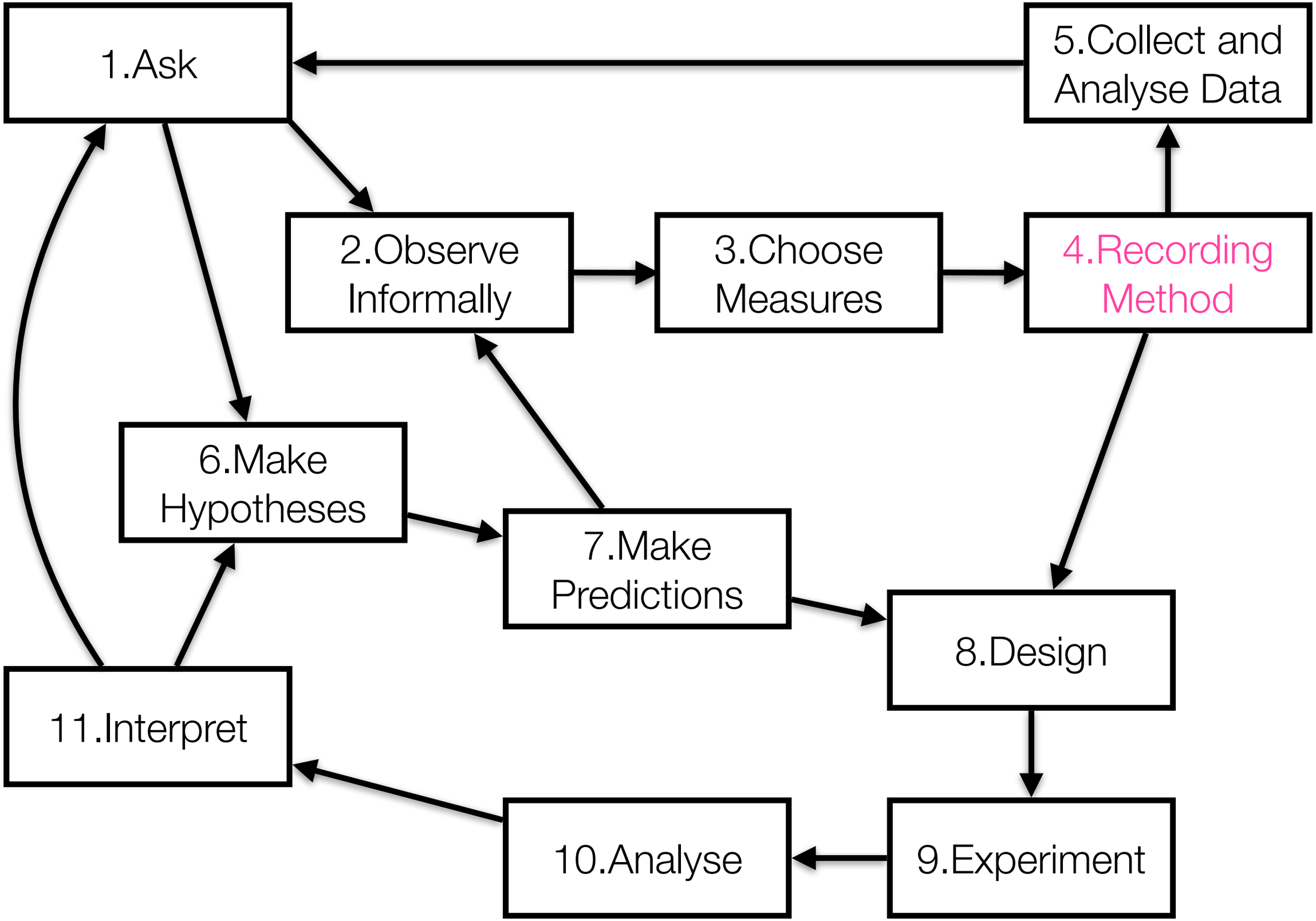

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Choose Suitable Sensors

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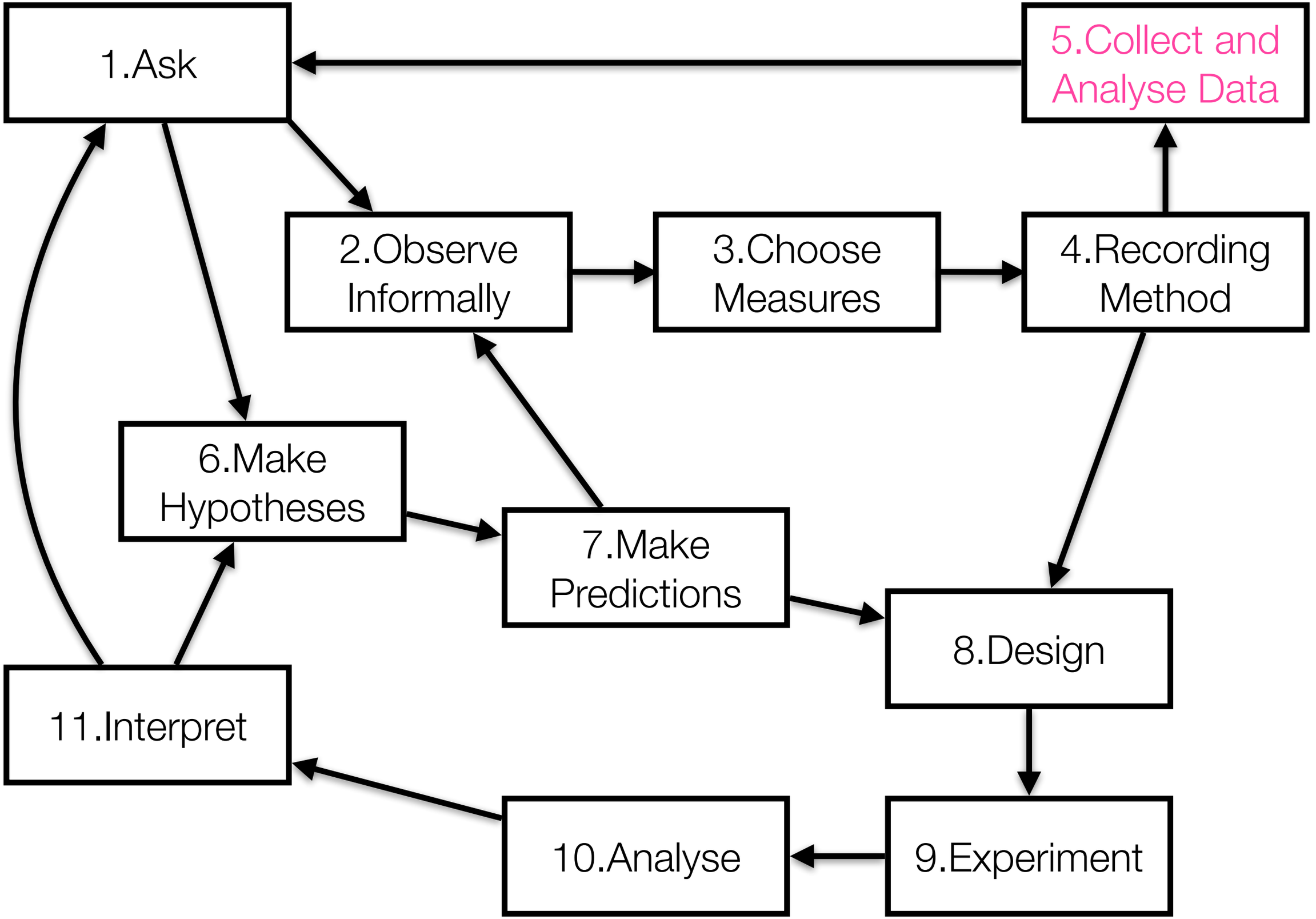

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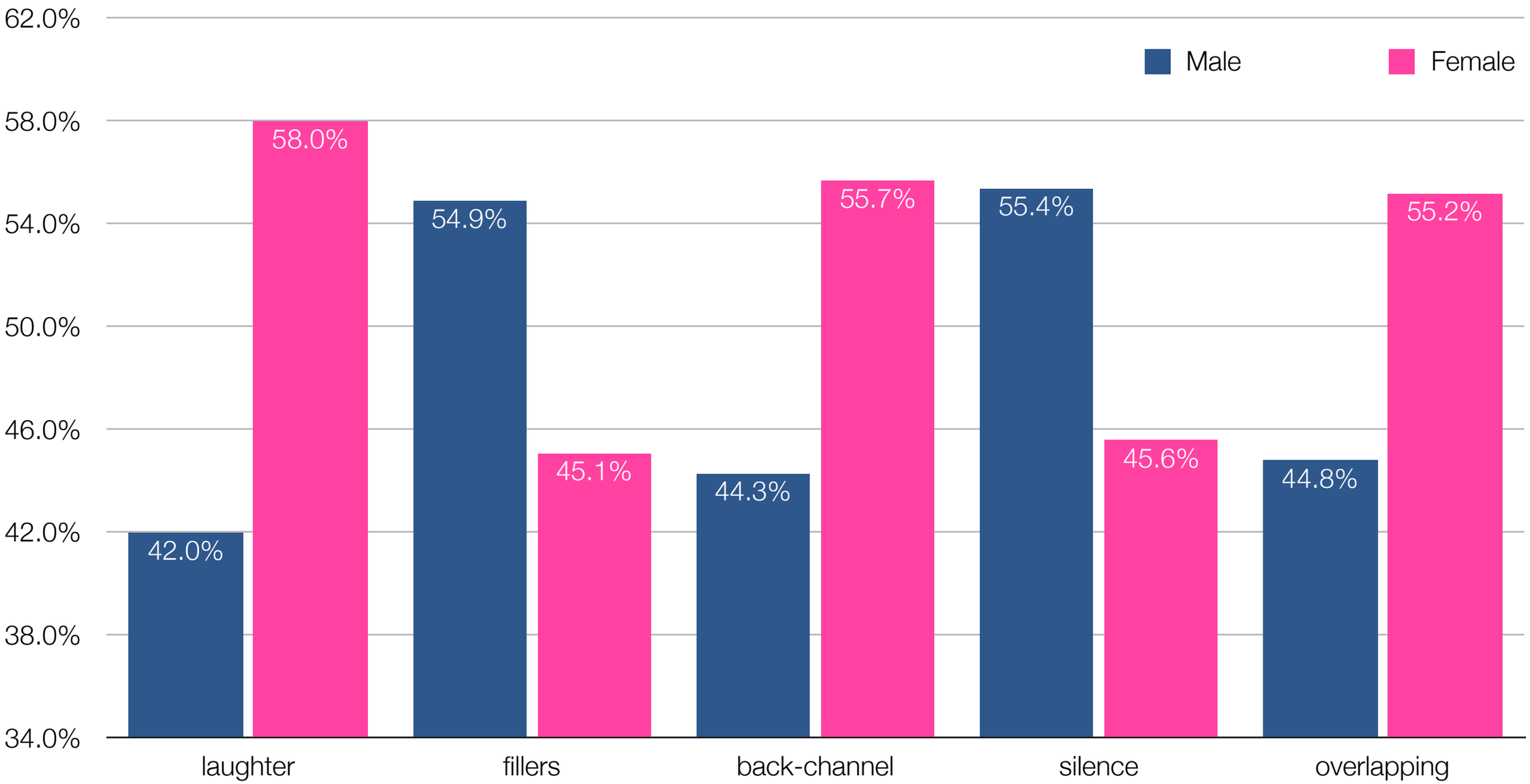
Collect and Analyse Data (I)



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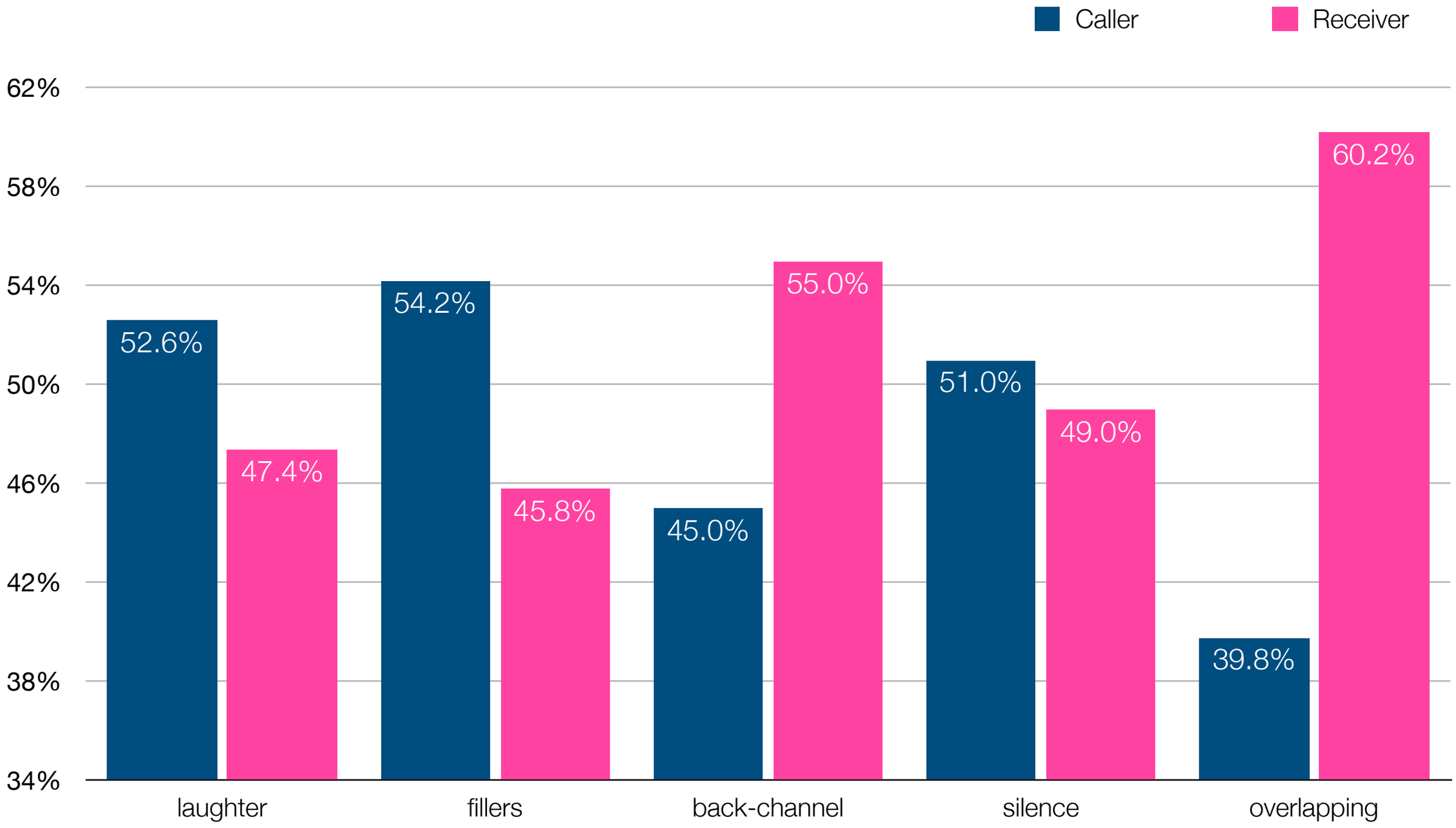

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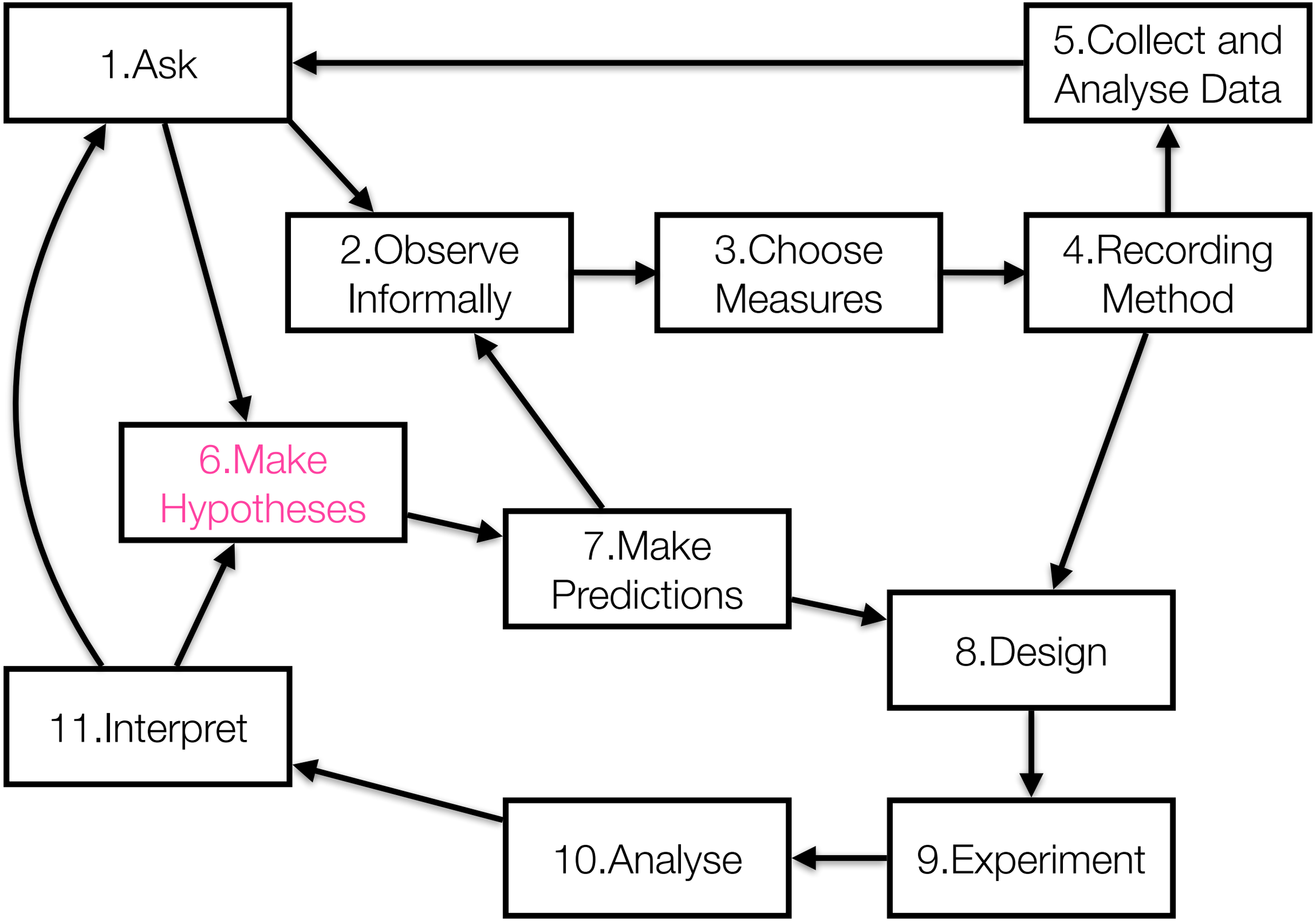

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Formulate Precise Hypotheses (I)

- A Research Hypothesis (or the underlying Research Question) is a statement that can be falsified through the application of Hypothesis Testing methodologies;
- In the most common form, a Research Hypothesis is a statement about an observable difference between different populations;
- In the case of Social AI, the populations are typically groups of persons who share a common characteristic under analysis (e.g., gender or role).

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Formulate Precise Hypotheses (II)

- Female and Male speakers display nonverbal behavioural cues (laughter, fillers, back-channel, silence, overlapping) a different number of times per time unit;
- Callers and Receivers display nonverbal behavioural cues (laughter, fillers, back-channel, silence, overlapping) a different number of times per time unit.

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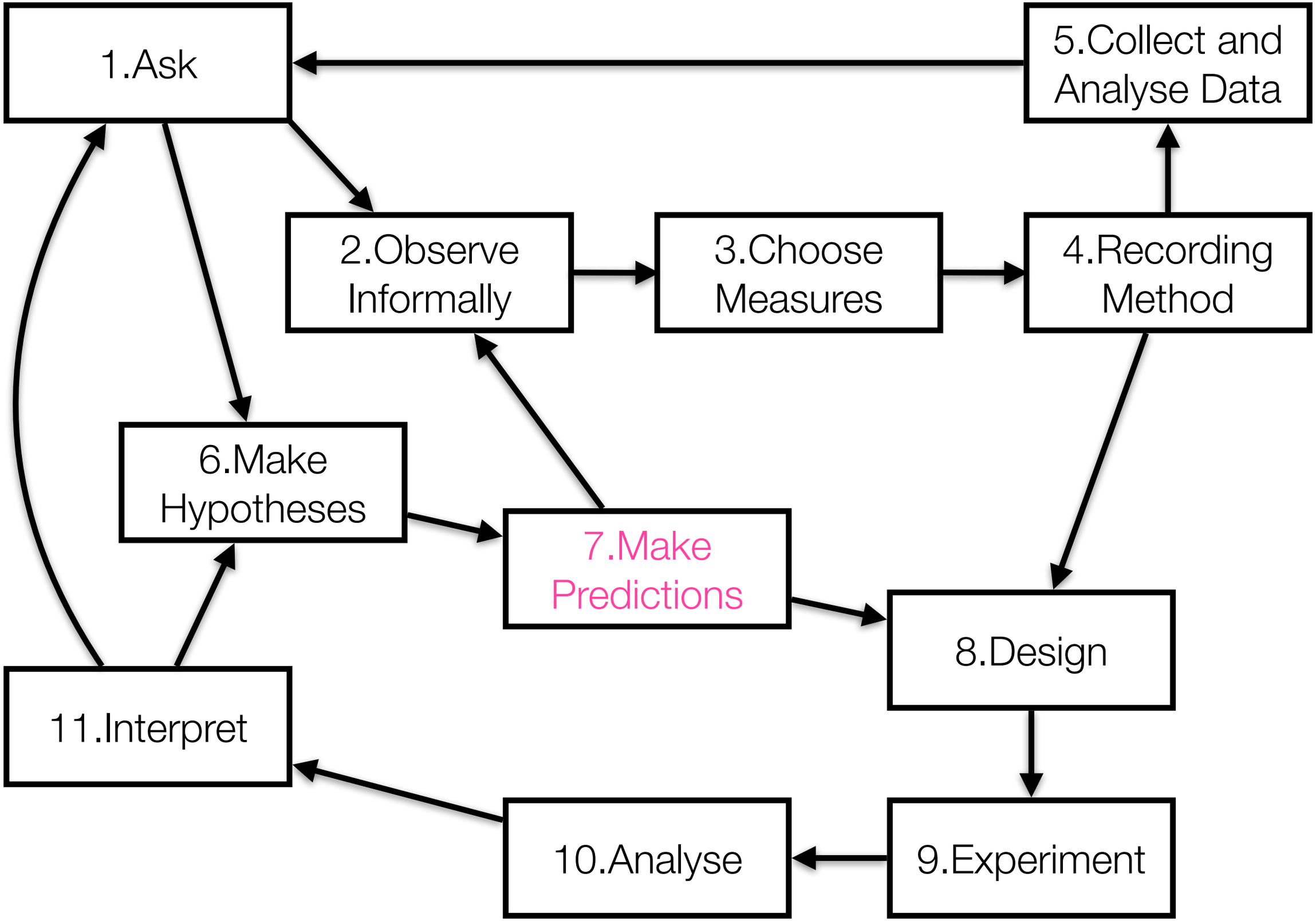

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Make Predictions

- Female speakers display nonverbal behavioural cues (laughter, fillers, back-channel, silence, overlapping) more frequently than Male speakers;

- Callers display nonverbal behavioural cues (laughter, fillers, back-channel, silence, overlapping) more frequently than Receivers.

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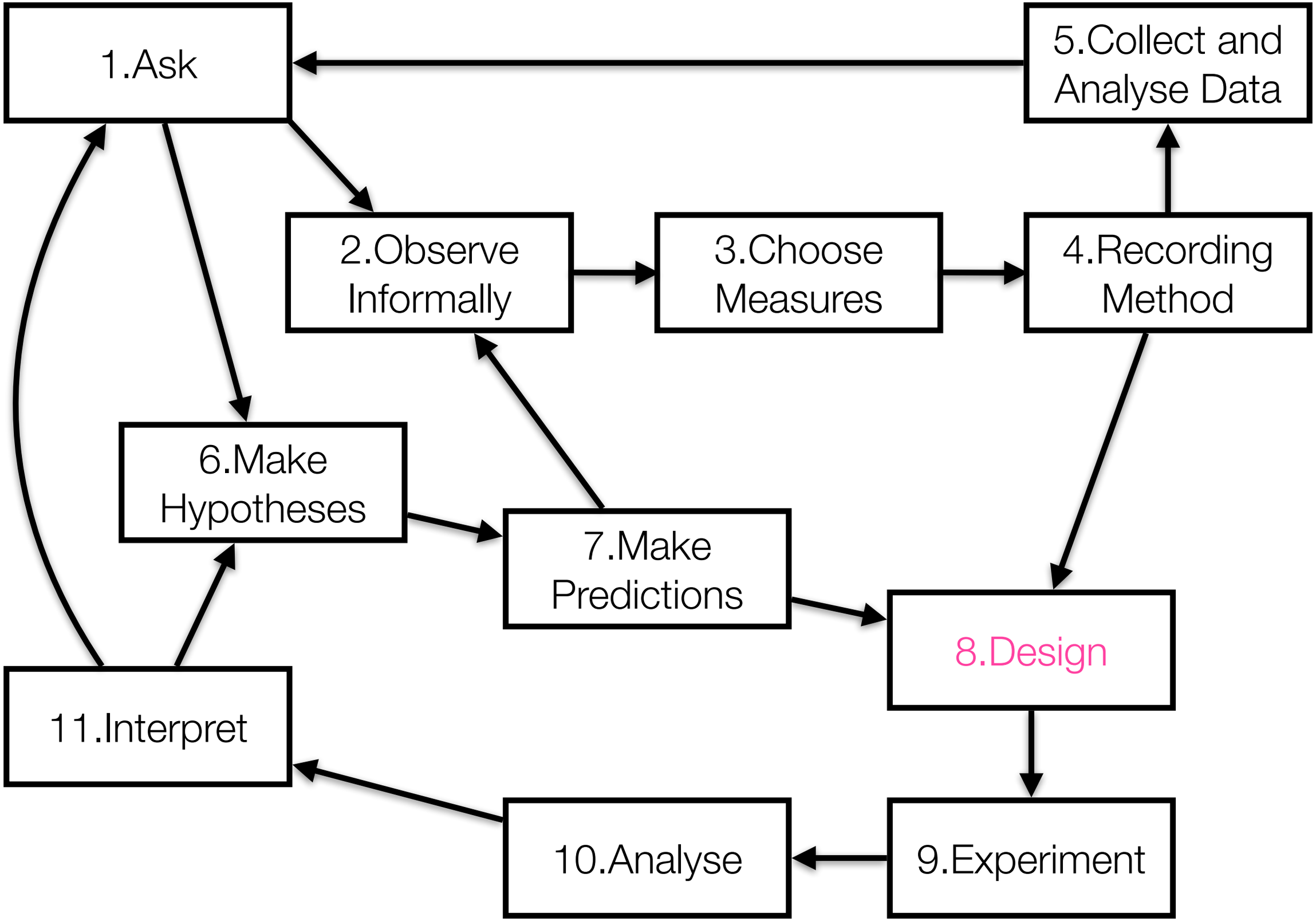

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Design the Tests (I)

$$\chi^2 = \sum_{k=1}^{N} \frac{(O_k - E_k)^2}{E_k}$$

- The Observations O_k are the number of times people in group k (e.g., Female speakers) display a certain nonverbal behavioural cue (e.g., laughter);
- The Expectations E_k are the number of times members of group k are expected to display a cue in case there is no difference between groups.

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Design the Tests (II)

$$p(\chi^2) = \frac{1}{2^{\frac{d}{2}}\Gamma(\frac{d}{2})}(\chi^2)^{\frac{d}{2}-1}e^{-\frac{1}{2}\chi^2}$$

- The probability density function of variable χ^2 is known when the Null Hypothesis is true;
- The Null Hypothesis states that there is no difference between the groups under analysis'
- The parameter d, the degrees of freedom, is equal to $N-1$, where N is the number of groups.

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Design the Tests (III)

$$p(\chi^2) = \frac{1}{2^{\frac{d}{2}}\Gamma(\frac{d}{2})}(\chi^2)^{\frac{d}{2}-1}e^{-\frac{1}{2}\chi^2}$$

- When $p(\chi_o^2) < 0.05$, where χ_o^2 is the value of the χ^2 variable observed for the data, the Null Hypothesis can be rejected;
- The reason is that $p(\chi_o^2) < 0.05$ means that the probability of the observed χ_o^2 is low when the Null Hypothesis is true.

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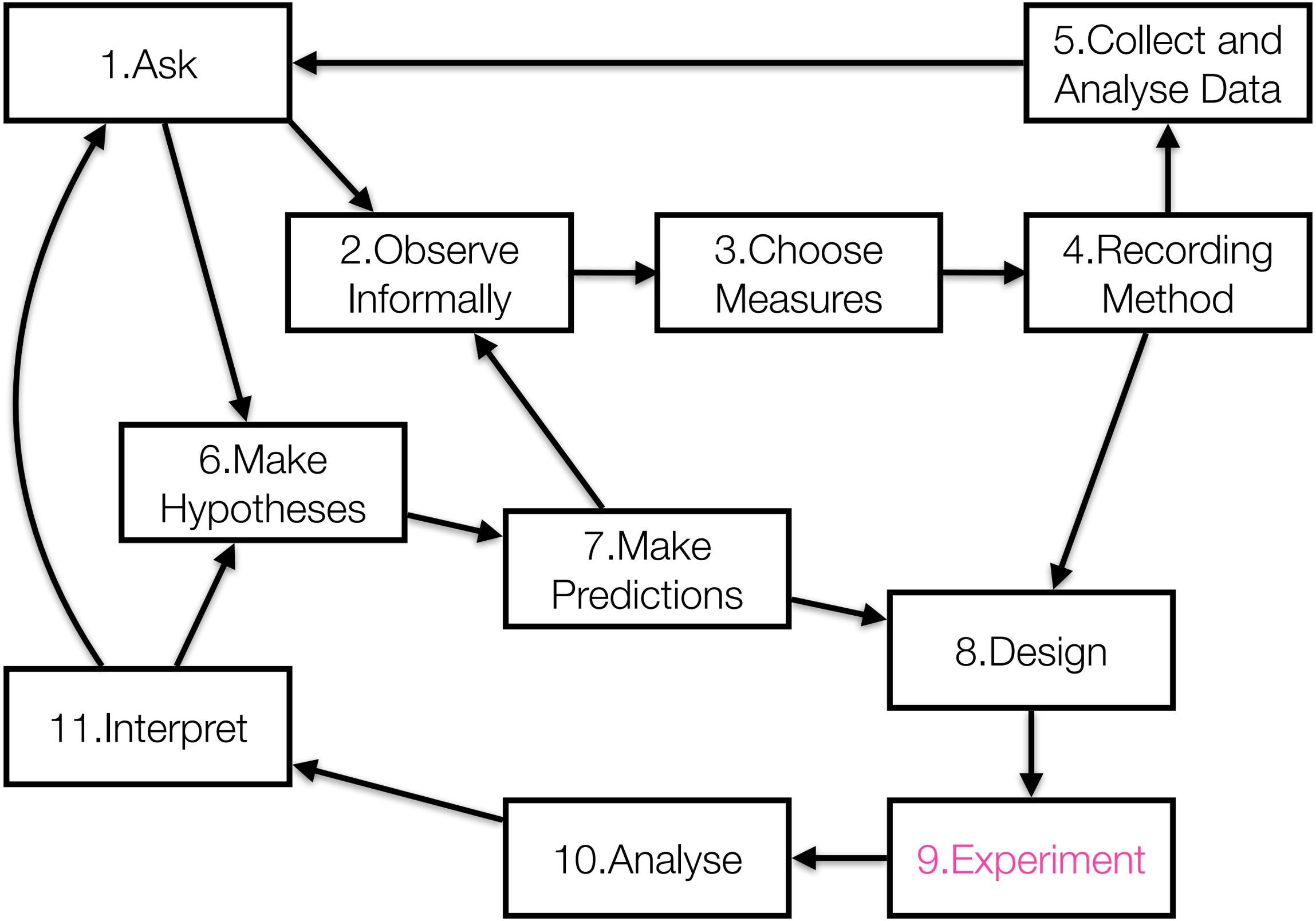

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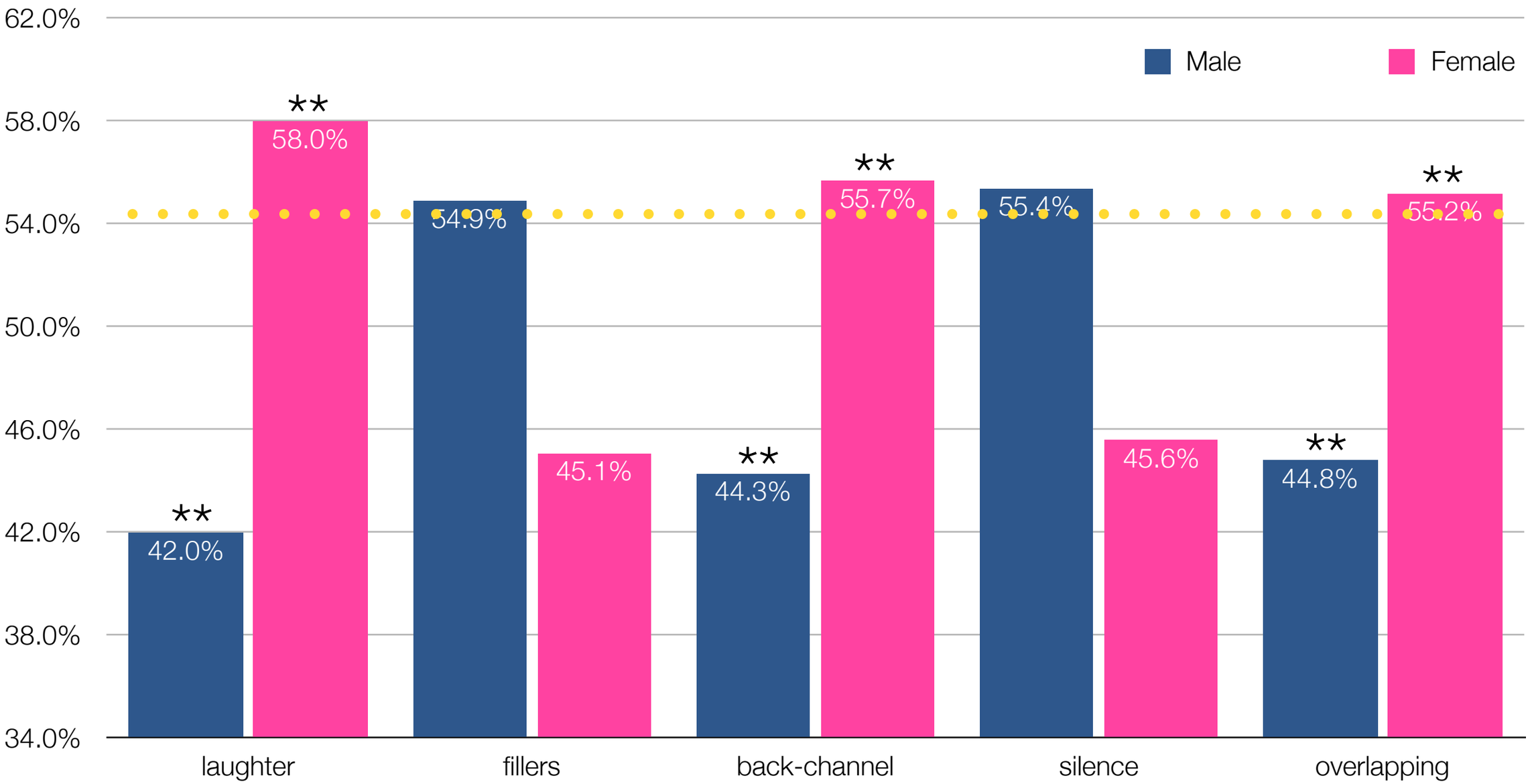
Test your Hypothesis (I)



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Formulate Precise Hypotheses (II)

- Female speakers laugh more frequently than how expected when the Null Hypothesis is true ($p < 0.01$), the difference is statistically significant;
- Female speakers display back-channel more frequently than how expected when the Null Hypothesis is true ($p < 0.01$), the difference is statistically significant;
- Female speakers interrupt more frequently than how expected when the Null Hypothesis is true ($p < 0.01$), the difference is statistically significant.

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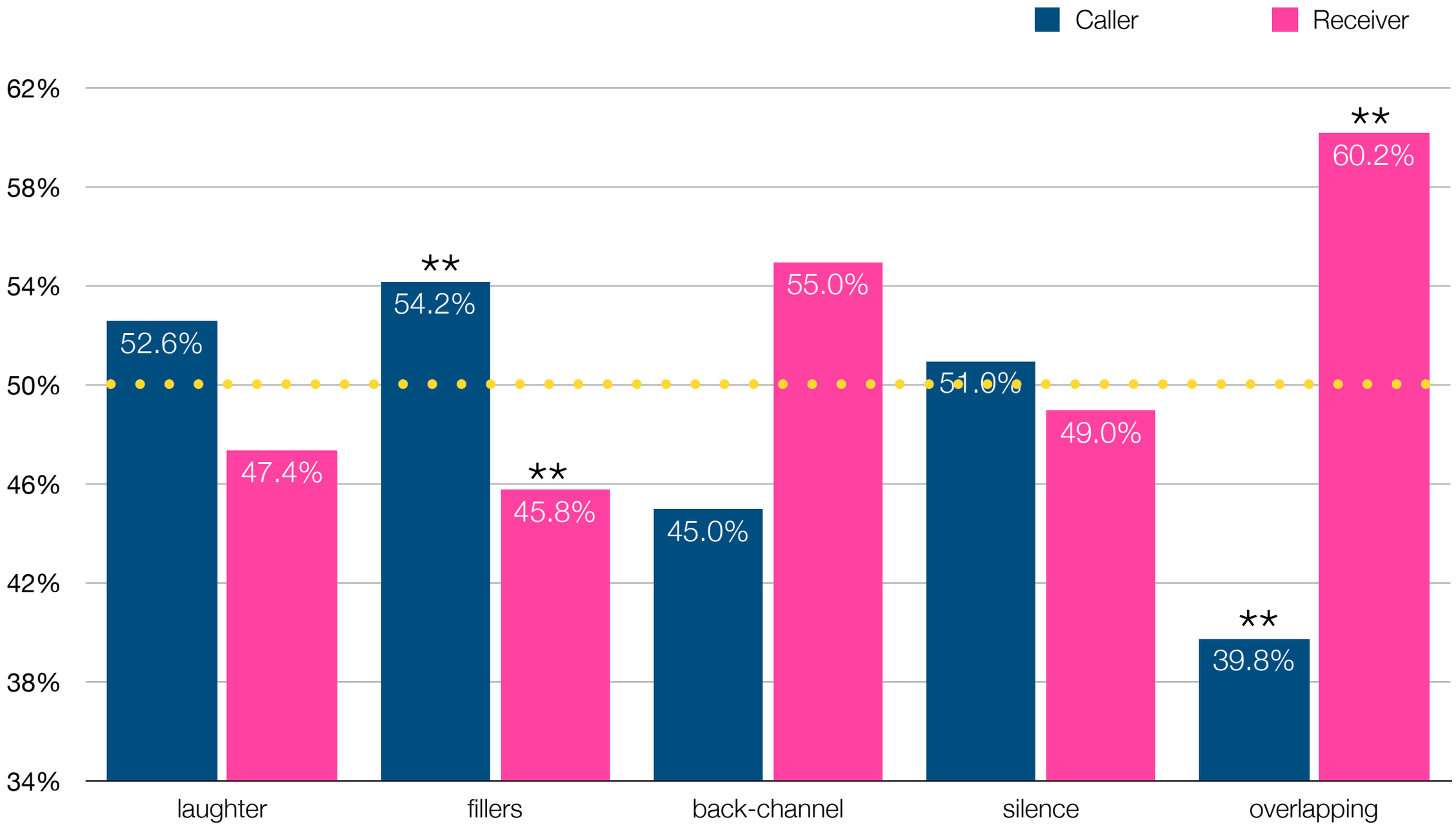
Test your Hypothesis (III)



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Formulate Precise Hypotheses (IV)

- Callers display fillers more frequently than how expected when the Null Hypothesis is true ($p < 0.01$), the difference is statistically significant;
- Receivers interrupt more frequently than how expected when the Null Hypothesis is true ($p < 0.01$), the difference is statistically significant.

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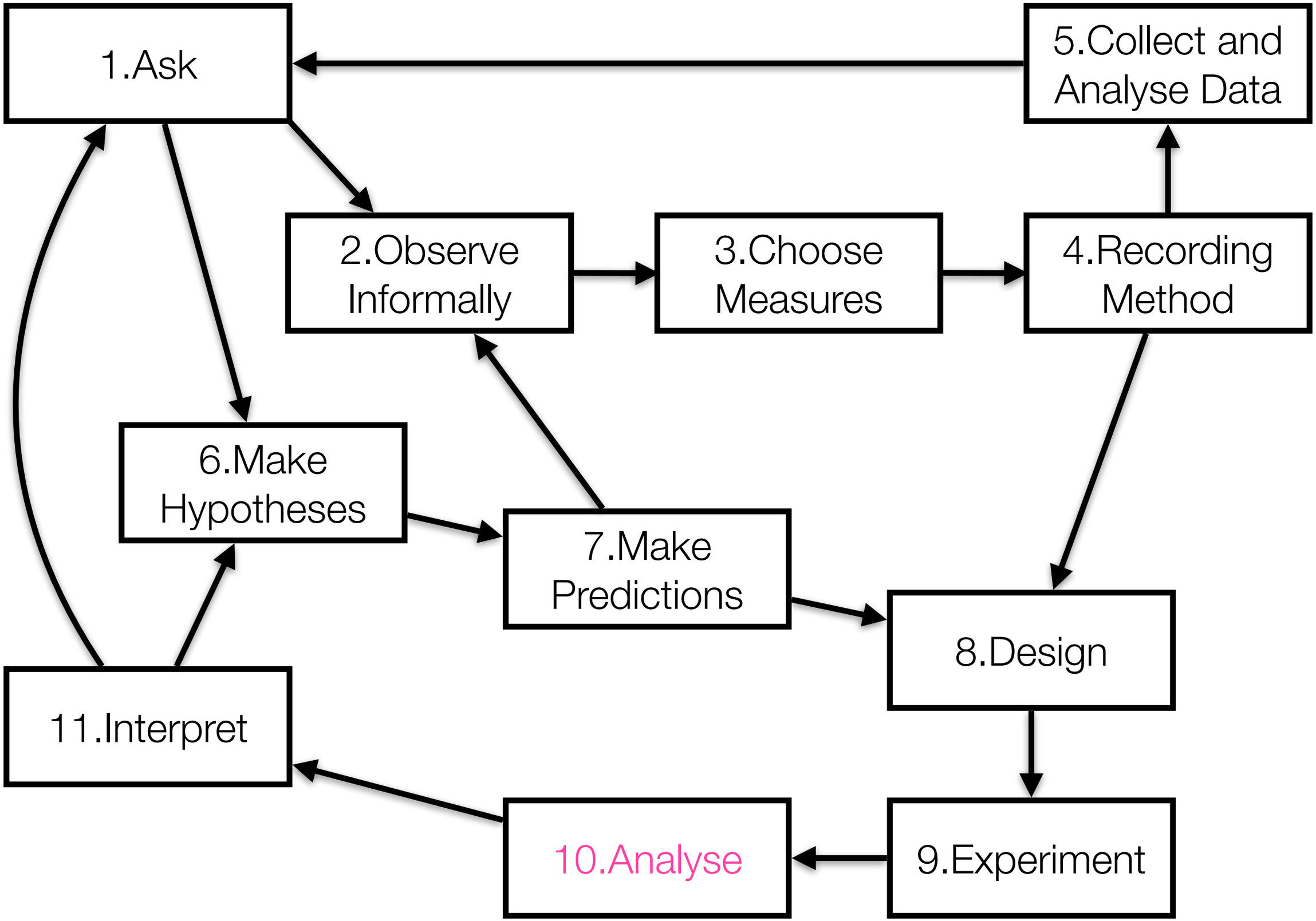

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Analyse the Results

- There is a difference between the way Female and Male speakers use nonverbal communication in dyadic phone calls;
- There is a difference between the way Callers and Receivers use nonverbal communication in dyadic phone calls;
- There is a relationship between major social dimensions (gender and role) and use of nonverbal communication.

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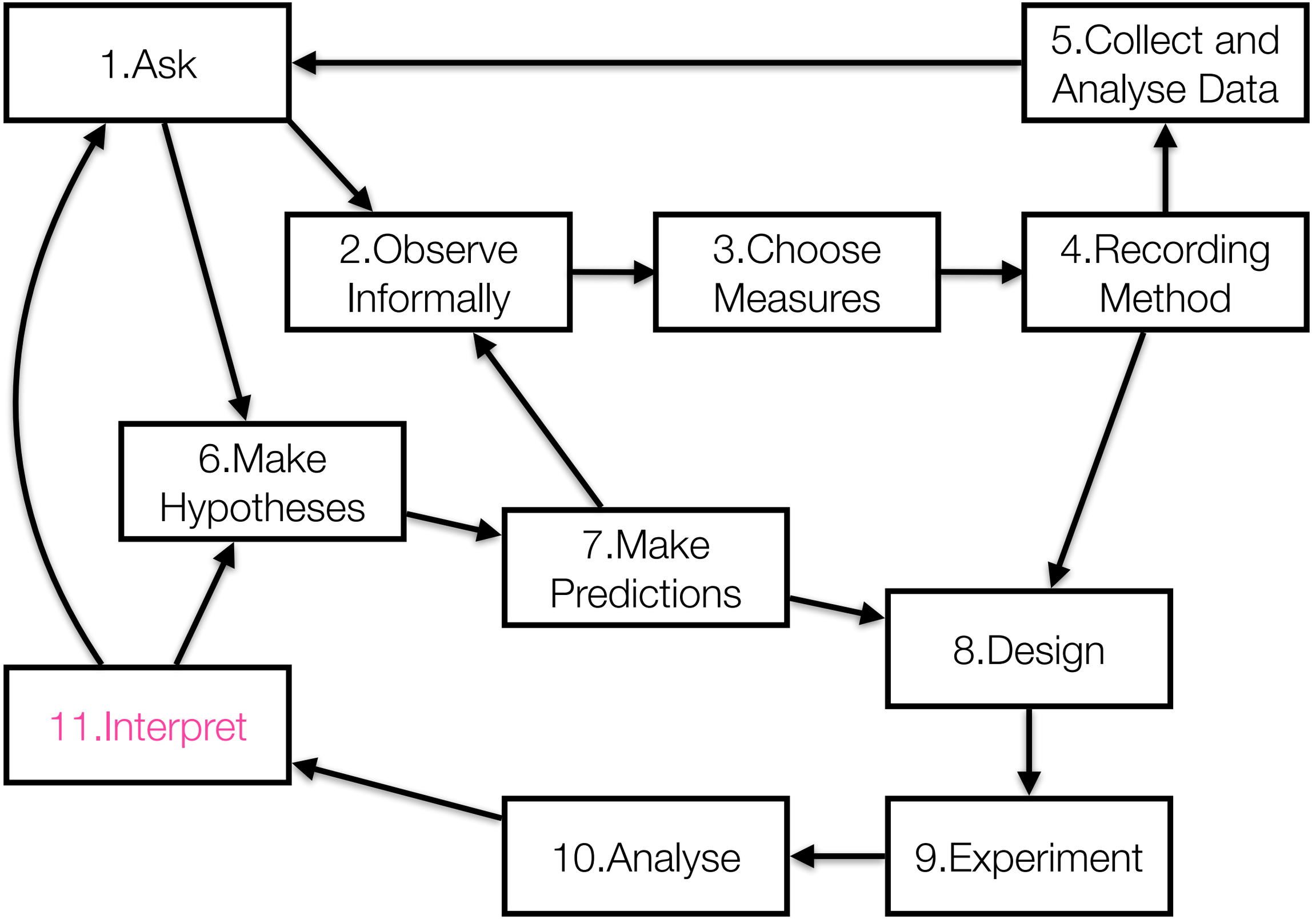

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Consider Alternative Interpretations

- The observed differences are compatible with the perception of differences in social status;
- The scenario does not introduce social verticality differences and the members of the same dyad do not have any information about one another;
- The alternative interpretation should be supported by the literature.

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Consider Alternative Interpretations

"[…] men and women are generally perceived as differing in status (importance, dominance, power, etc.) and also that they often feel themselves to differ in this way."

Leffler, Gillespie & Conaty, "The Effects of Status Differentiation on Nonverbal Behavior", Social Psychology Quarterly, 45(3):153–161, 1982

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Consider Alternative Interpretations

"[…] when communicating with a higher status person, the lower status person [...] has more filled and unfilled pauses than normal"

Richmond, McCroskey & Payne, "Nonverbal Behavior in Interpersonal Relations", Prentice Hall, 1991

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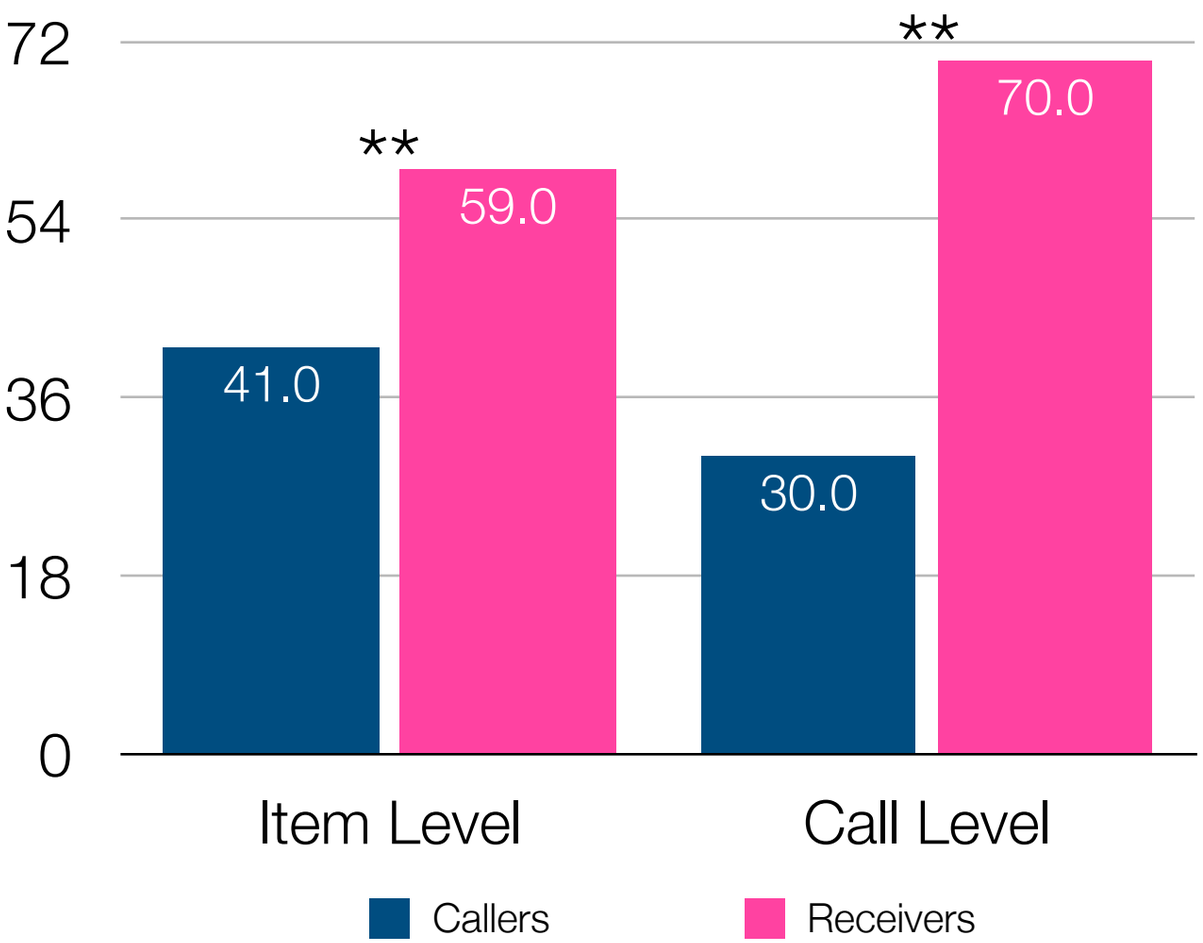
Consider Alternative Interpretations



Receivers win against callers in 59% of the negotiations (70% of the times at the call level).

Calling or receiving makes the difference ($p<0.005$).

Vinciarelli, Salamin & Polychroniou, “Negotiating Over Mobile Phones: Calling or Being Called can Make the Difference”, Cognitive Computation, Vol. 6, no. 4, pp. 677-688, 2014.

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Outline

- The 11 Steps of Behaviour Observation
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Conclusions

- The 11 steps are not a recipe, they are a list of scientific and methodological issues typically addressed when analysing scientifically behaviour;
- Observing behaviour is art and science, the methodologies are rigorous and data-driven, but they require intuition and experience;
- Human behaviour is not random, but it is not deterministic either, observation is about finding regularities and principles.

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Thank You!

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