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The Awareness Attribution Scale: Development, Validation, and Short-Form Reduction

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Abstract. This research introduces the Awareness Attribution Scale (AAS), a tool for measuring how humans attribute awareness to a variety of entities, including artificial agents. Grounded in philosophical theories of consciousness, the scale is designed to assess 14 core constructs of awareness, each represented by a single item. Study 1 identified the most comprehensible item for each construct. Study 2 confirmed the internal consistency of the resulting 14-item scale in a context where participants imagined an interaction with a humanoid robot. Study 3 validated the scale across four distinct entities (rock, robot, dog, and human), demonstrating its ability to discriminate between levels of perceived awareness. Finally, Study 4 used Exploratory Factor Analysis (EFA) to create a reliable 5-item short form, offering a more efficient version for time-constrained settings. The AAS provides a validated, theoretically grounded, and accessible tool for empirical research on awareness attribution.

Keywords: Human-Robot Interaction, Awareness Attribution, Social Robots.

1 Introduction

Understanding how people attribute awareness to other entities (particularly artificial agents) has become increasingly relevant in fields such as Human-Robot Interaction (HRI), social cognition, and philosophy of mind. While previous studies investigated the attribution of intentionality [1], agency [2], or various mental states [3], they did not provide systematic assessments of awareness attribution. This study introduces the Awareness Attribution Scale (AAS), a validated tool to assess how humans attribute awareness to a range of entities including, but not limited to, social robots.

Based on philosophical work in consciousness studies, we identified 14 key constructs that form the theoretical foundation of awareness. These constructs are *qualitative richness, situatedness, intentionality, integration, dynamics and stability, subjectivity, self-consciousness, phenomenal structure, goal-directed behavior, brain anatomy and physiology, psychometric performance, episodic memory, illusion and multistable perception, and visuospatial behavior* [4, 5, 6]. Each of these constructs reflect different elements that constitute awareness.

Based on this, our purpose was to develop a questionnaire, in a scale format, containing one item per construct, each designed to measure the attribution of that particular aspect of awareness. Four sequential studies were carried out to develop, refine, and validate the scale. The first study concentrated on item clarity while the second study assessed internal consistency within an imagined environment. The third study confirmed scale validity across various entities before the fourth study minimized the scale using an EFA to establish a version that works well in time-restricted situations.

2 Study 1: Ease of Understanding

2.1 Introduction

The aim of Study 1 was to create a scale that could reliably measure attributed awareness using language that is accessible to the general public. Given that awareness-related constructs are often described using technical terminology, this study focused on ensuring that each item was easy to understand. To accomplish this, three candidate items were written for each of the 14 constructs that were theorized to constitute awareness. The objective was to empirically identify the easiest item to understand in each group, ultimately producing a 14-item scale ready for further testing.

2.2 Method

The study was conducted online via Qualtrics. The sample was of 98 participants recruited via Prolific (49 females, 49 males) with an average age of 29.29 years (SD = 8.95). Participants with academic training in psychology or philosophy were screened out to capture how non-experts interpreted the items.

A total of 42 items were generated, with three items per awareness-related construct. These items were grouped into 14 sets, each representing a distinct construct. The subject in all statements was kept neutral ("The main character"). Participants were asked to rate the comprehensibility of each item within a set, selecting which of the three was the easiest and hardest to understand.

2.3 Results

The results revealed the items that participants found easiest to understand within each of the 14 awareness-related constructs. Lower values indicated greater ease of understanding. These were the selected items:

The main character…

- Q01 - can have intense experiences (M = 1.40, SD = 0.65) (*Qualitative Richness*).
- Q02 - can perceive differently based on life experiences (M = 1.69, SD = 0.84) (*Situatedness*).
- Q03 - can think about an idea (M = 1.33, SD = 0.67) (*Intentionality*).

- Q04 - can understand different information to create a unified experience (*M* = 1.43, *SD* = 0.61) (*Integration*).
- Q05 - can evolve while maintaining the same identity (*M* = 1.40, *SD* = 0.70) (*Dynamics and stability*).
- Q06 - has its own identity (*M* = 1.73, *SD* = 0.73) (*Subjectivity*).
- Q07 - knows that it has its own identity (*M* = 1.73, *SD* = 0.75) (*Self-consciousness*).
- Q08 - can understand why it has its own identity (*M* = 1.69, *SD* = 0.74) (*Phenomenal structure*).
- Q09 - can plan actions to achieve desired results (*M* = 1.41, *SD* = 0.66) (*Goal-directed behavior and model-based learning*).
- Q10 - has mind processes similar to the ones happening in a brain (*M* = 1.76, *SD* = 0.86) (*Brain anatomy and physiology*).
- Q11 - can think about its thoughts and experiences (*M* = 1.29, *SD* = 0.57) (*Psychometric performance and metacognitive judgement*).
- Q12 - can think about what it did in the past (*M* = 1.32, *SD* = 0.60) (*Episodic memory*).
- Q13 - can experience optical illusions or other perception illusions (*M* = 1.37, *SD* = 0.65) (*Illusion and multistable perception*).
- Q14 - can know where it is (*M* = 1.38, *SD* = 0.71) (*Visuospatial behavior*).

2.4 Conclusion

Study 1 successfully identified one easy-to-understand item for each of the 14 awareness constructs. This resulted in a preliminary 14-item version of the AAS.

3 Study 2: Validation of the AAS in an Imagined Context

3.1 Introduction

Study 2 aimed to evaluate the internal consistency of the 14-item AAS which originated from Study 1. Cronbach's alpha was used to verify the reliability of the 14-item set. For this study, all 42 original items (three per construct) were included in case any of the selected items needed to be replaced based on poor psychometric performance.

3.2 Method

The study was conducted online via Qualtrics. The sample consisted of 98 participants (via Prolific): 61 females, 36 males, and one participant who preferred not to say. The average age was 40.26 years (*SD* = 13.29).

Participants were asked to imagine themselves interacting with a robot capable of showing behavior indicative of having awareness. Then, they were instructed to evaluate this robot using the 42 items (three per construct) on a 5-point Likert scale ranging from 1 (Strongly disagree) to 5 (Strongly agree). The higher the score, the greater the degree of awareness the participant attributed to the robot.

3.3 Results

The internal consistency of the 14-item scale was excellent, with a Cronbach's alpha of 0.91. Given this high level of reliability, there was no need to substitute any of the items. The mean awareness attribution score across participants was 3.20 (*SD* = 0.79), indicating a moderate tendency to attribute awareness to the imagined robot.

3.4 Conclusion

The scale demonstrated excellent internal consistency, supporting its use as a valid and reliable instrument for assessing attributed awareness.

4 Study 3: Validating the AAS Across a Spectrum of Entities

4.1 Introduction

This study aimed to validate the AAS by testing if it could meaningfully differentiate between entities that vary in their perceived level of awareness. Building on the framework introduced by Gray et al. (2007) [7], four target entities were chosen: a rock (on the extreme lower end of awareness), a social robot (relevant entity for future applications of this scale), a dog (in the middle of the spectrum and familiar to participants), and a human (on the extreme higher end). The goal was to examine whether the scale would retain internal consistency in each context.

4.2 Method

The study was conducted online via Qualtrics. A total of 200 participants were recruited via Prolific; 106 females, 93 males, and one participant who did not declare their gender. The average age was 37.41 years (SD = 13.20).

Participants rated each of the four entities using the 14-item AAS. For each item, they were shown the name and an image of the entity (created using DALL·E) and asked to indicate their rating on a 5-point Likert scale, as in the previous study. Both items and entities were presented in a randomized order to minimize potential ordering effects.

4.3 Results

The AAS successfully distinguished between entities in terms of attributed awareness. The human had the highest score (*M* = 4.90, *SD* = 0.15), followed by the dog (*M* = 3.87, *SD* = 0.54), the social robot (*M* = 2.83, *SD* = 0.74), and the rock (*M* = 1.20, *SD* = 0.33). Qualtrics.

Internal consistency was calculated separately for each entity. The scale demonstrated good reliability for the robot (α = 0.88) and dog (α = 0.84), and acceptable reliability for the rock (α = 0.78). The human, however, showed lower reliability (α = 0.64). A ceiling effect probably caused this outcome since most participants provided high

ratings which decreased variance and lowered the alpha coefficient. The rock ratings probably experienced a floor effect that was similar but not as severe.

4.4 Conclusion

Study 3 provided strong support for the validity of the AAS. While ceiling and floor effects may affect reliability at the extremes (human and rock), the scale performed reliably for mid-spectrum entities, especially the social robot, which is of particular interest in HRI research.

5 Study 4: Exploratory Factor Analysis and Scale Reduction

5.1 Introduction

Although the 14-item AAS demonstrated strong reliability, there are situations in which administering a shorter version of the scale would be more practical; for example, studies involving children or time-constrained experimental settings. This study aimed to shorten the AAS into a 5-item form while maintaining the same conceptual integrity.

5.2 Method

An EFA was used to analyze the 14-item scale and choose the specific items that formed the shorter version. This analysis used the data extracted from the ratings given to the social robot in Study 3. This represents the primary target of the scale's intended application (artificial agents) and showed strong internal consistency ($\alpha = 0.88$).

5.3 Results

The Kaiser-Meyer-Olkin (KMO) value was 0.892, and the Bartlett's Test of Sphericity was highly significant ($\chi^2(91) = 1027.30$, $p < .001$). An EFA using Principal Axis Factoring with Direct Oblimin rotation was conducted. A visual inspection of the scree plot supported the extraction of two factors, which accounted for a meaningful proportion of the variance. The Pattern Matrix revealed that the first factor included items centered on subjective experience, identity, and metacognition. The strongest loadings on this factor were Q07 (loading = .795), Q11 (loading = .738), and Q02 (loading = .699). The second factor focused on the capability of an agent to act deliberately and locate itself in time and space. The two items with the strongest loadings were Q09 (loading = .887) and Q12 (loading = .509). The 5-itme scale had a Cronbach's alpha of $\alpha = .793$, indicating that it is a reliable scale despite the reduced number of items.

5.4 Conclusion

This shorter version maintains good internal consistency and offers a practical alternative without sacrificing theoretical and psychometric integrity.

6 Conclusion

The four consecutive studies have developed and validated the AAS as a versatile tool suitable to measure how humans attribute awareness to various entities, including artificial agents. The scale was created by first establishing a 14-construct philosophical basis and then performing successive tests to assess clarity and reliability. While the full 14-item tool gives a thorough overview of attributed awareness, the 5-item version maintains its reliability for quick assessments. The scale demonstrated exceptional performance when applied to mid-range entities like social robots thereby proving its usefulness for HRI studies.

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