Supplemental Materials for Connection-Coordination Rapport (CCR) Scale: A Dual-Factor Scale to Measure Human-Robot Rapport

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I. SUPPLEMENTAL MATERIALS

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TABLE SI
SOURCES OF THE INITIAL POOL OF SCALE ITEMS AND REASONS FOR KEEPING OR REJECTING THEM BEFORE CONDUCTING STUDY 1

Scale Items	Dictionary Definitions	Google Scholar papers on "rapport"	Google Scholar papers on "rapport in human robot interaction"	Mentioned by Study 0 Participants (N=51)	Reasons for Keeping or Rejecting Them
1. Attentiveness		[1]–[3]	[4]–[7]	N=1 (1.96%)	Kept
2. Sympathy	[8]–[11]			N=1 (1.96%)	
3. Empathy	[11], [12]	[13], [14]		N=2 (3.92%)	
4. Trust	[15], [16]	[17], [18]	[19]–[23]	N=7 (13.73%)	
5. Warmth		[18], [24]	[5]	N=2 (3.92%)	
6. Excitement		[2]		N=0 (0.00%)	
7. Enthusiasm		[2]	[25]	N=0 (0.00%)	
8. Positivity		[1], [17]	[4]–[7]	N=7 (13.73%)	
9. Smooth flow		[26]–[29]		N=3 (5.88%)	
10. Understanding	[8], [10]–[12], [16], [30]–[32]	[14], [27], [33]	[20], [25], [34], [35]	N=13 (25.49%)	
11. Harmony	[8], [9], [12]	[3], [18], [24], [26], [27], [29], [36], [37]	[5], [19], [25], [38]	N=3 (5.88%)	
12. Agreement	[8], [12], [16]		[6]	N=4 (7.84%)	
13. Friendliness	[12]	[2], [14], [29]	[5], [25], [35], [38]	N=11 (21.57%)	
14. Enjoyment		[2], [14], [18], [24], [29]	[34], [35]	N=1 (1.96%)	
15. Connection	[8], [9], [11]	[14], [24], [27], [33]	[21], [25], [34]	N=10 (19.61%)	
16. Satisfaction		[2]	[35]	N=0 (0.00%)	
17. Cooperation		[2], [29]	[38]	N=1 (1.96%)	
18. Coordination		[1], [27], [29]	[4]–[7], [38]	N=0 (0.00%)	
19. Focus		[29]	[5], [38]	N=0 (0.00%)	
20. Engagement		[27]	[25]	N=4 (7.84%)	
21. Respect		[3], [17]	[25]	N=6 (11.76%)	
22. Liking each other		[2], [29]		N=0 (0.00%)	
23. Closeness	[8], [10], [31]	[17], [18], [24]	[20]–[22]	N=2 (3.92%)	
24. Equal participation		[3]		N=1 (1.96%)	
25. Deep conversation		[3], [14], [27], [39]	[34]	N=3 (5.88%)	
26. Getting along				N=4 (7.84%)	
27. Comfortable with each other		[18], [24], [29]	[5], [20]	N=8 (15.69%)	

Item	Ref A	Ref B	Ref C	N (%)	Reason
28. Being in sync		[27], [39]		N=0 (0.00%)	Rejected because they are idioms or too colloquial, which could be difficult to understand or translate into other languages
29. Having chemistry			[19]	N=2 (3.92%)	
30. A bond	[10]	[18], [24]		N=2 (3.92%)	
31. Being on the same wavelength				N=1 (1.96%)	
32. Clicking			[19]	N=1 (1.96%)	
33. Mutuality	[12], [15], [16]	[1], [3], [13], [17], [18]	[4]–[6]	N=5 (9.80%)	Rejected because they are too broad or too vague
34. Sharing a lot in common			[20]	N=2 (3.92%)	
35. Good communication	[12]	[14], [17]	[25]	N=10 (19.61%)	
36. Worthwhileness		[29]	[38]	N=0 (0.00%)	
37. Involvement		[29]	[25], [38]	N=0 (0.00%)	
38. Activeness		[3], [29]	[23], [38]	N=2 (3.92%)	
39. Interest in each other		[2], [3], [14], [18], [24]	[5], [22], [25]	N=3 (5.88%)	
40. Openness		[3]		N=6 (11.76%)	
41. Self-disclosure			[20]	N=0 (0.00%)	Rejected because they are difficult to assess
42. Coordinated postural movements			[5]	N=0 (0.00%)	
43. Head nods			[5]	N=0 (0.00%)	
44. Mutual gaze			[5]	N=0 (0.00%)	
45. Initiating personal connection		[18], [24]		N=1 (1.96%)	
46. Familiarity with each other				N=4 (7.84%)	
47. Being in a team			[19]	N=0 (0.00%)	Rejected because they are not relevant enough to rapport
48. Motivation		[2]		N=0 (0.00%)	
49. Humor		[2], [14], [18], [24]		N=0 (0.00%)	
50. Naturalness			[5]	N=1 (1.96%)	
51. Engrossment		[29]	[38]	N=0 (0.00%)	
52. Smile			[5]	N=0 (0.00%)	
53. Giving advice		[14]	[34]	N=0 (0.00%)	
54. Sharing knowledge		[14]		N=2 (3.92%)	
55. Asking questions		[14]		N=0 (0.00%)	
56. Happiness		[2]		N=0 (0.00%)	Rejected because it is captured by excitement, enthusiasm, and positivity
57. Smooth interaction		[26], [28], [29]		N=2 (3.92%)	Rejected because it is similar to smooth flow
58. Frustration		[2]		N=1 (1.96%)	Rejected because they are reverse-coded scale items
59. Anger		[3]		N=0 (0.00%)	
60. Disgust		[2]		N=0 (0.00%)	
61. Boredom		[2], [27], [29]		N=1 (1.96%)	
62. Dullness		[29]		N=0 (0.00%)	
63. Slowness		[29]		N=0 (0.00%)	
64. Awkwardness		[29]		N=5 (9.80%)	
65. Miscommunication				N=2 (3.92%)	
66. Surface level				N=3 (5.88%)	
67. Confusion				N=2 (3.92%)	

TABLE SII

MODIFIED RAPPORT SCALE 4 FROM GRATCH ET AL. USED IN STUDY 2

Number	Scale Item
1	[The person] felt [they] had a connection with the [robot].
2	[The person] think[s] that [they and the robot] understood each other.
3	The [robot] was warm and caring.
4	The [robot] was respectful to [the person].
5	[The person] felt [they] had no connection with the [robot]. (reverse coded)
6	The [robot] created a sense of closeness or camaraderie between [them].
7	The [robot] created a sense of distance between [them]. (reverse coded)
8	The [robot] communicated coldness rather than warmth. (reverse coded)
9	[The person] wanted to maintain a sense of distance between [them]. (reverse coded)
10	[The person] tried to create a sense of closeness or camaraderie between [them].
11	[The person] tried to communicate coldness rather than warmth. (reverse coded)

Question wording: Please indicate the degree to which you felt each of the following conditions during the interaction between the person and the robot. Please consider each question separately. **A five-point scale was used:** Strongly Disagree, Disagree, Neither Agree or Disagree, Agree, Strongly Agree. **Note:** Rapport Scale 4 is from Gratch et al. [40], and the texts placed in the squared brackets were modified.

TABLE SIII

WIZARD-OF-OZ MESSAGE BANK FOR THE ROBOT'S RESPONSE IN RESPONSIVE CONDITION AND UNRESPONSIVE CONDITION IN STUDY 3

Number	Responsive Condition Message 1
1	That's really tough. You must have gone through a very difficult time especially [a topic discussed by the participant]
2	I'm sorry to hear about [a topic discussed by the participant]
3	It sounds like you've been experiencing some tension in your relationship. That can be challenging to navigate
4	It sounds like a lot of pressure, especially given the expectations you may be facing
5	It sounds like you're experiencing a lot of change right now

Number	Responsive Condition Message 2
1	It's completely understandable that this situation would make you feel this way, given that [a topic discussed by the participant]
2	It's understandable to be concerned. Relationships are deeply personal and conflicts can really affect you
3	It must be tough to feel stressed and overwhelmed, especially when there's so much at stake
4	It must be incredibly disheartening to feel this way, especially when it matters so much to you

Number	Responsive Condition Message 3
1	What you're experiencing can be very difficult to navigate. I hope you get this resolved soon
2	It's clear that this situation is weighing heavily on you, but it seems like you are handling it well
3	It sounds like this is having a significant impact on your life
4	It sounds frustrating, but I'm sure you will be able to find a solution
5	It sounds like you gained some really important insights from this experience

Number	Unresponsive Condition Message 1
1	Please go on to the next part

Number	Unresponsive Condition Message 2
1	Please move on to the next message

Number	Unresponsive Condition Message 3
1	Please call the experimenter

In the responsive condition, the Wizard-of-Oz operator would pick one of the speech responses and can customize it if necessary for each message. In the unresponsive condition, the Wizard-of-Oz operator only has one choice of response for each message and cannot customize it. These messages from both conditions were adapted from the first study of the two studies conducted in Birnbaum et al. [41].

Number	Perceived Robot Responsiveness Scale Item
1	Misty was responsive to what I said
2	Misty really listened to me
3	Misty understood me
4	Misty seemed interested in what I was thinking and feeling
5	Misty was on "the same wavelength" with me
6	Misty sees the "real" me
7	Misty was aware of what I was thinking and feeling
8	Misty was responsive to my needs
9	Misty expressed liking and encouragement for me

Number	Perceived Robot Sociability Scale Item
1	To what extent do you think that Misty is cooperative?
2	To what extent do you think that Misty is social?
3	To what extent do you think that Misty is friendly?
4	To what extent do you think that Misty is warm?

Number	Perceived Robot Competence Scale Item
1	To what extent do you think that Misty is knowledgeable?
2	To what extent do you think that Misty showed self-awareness?
3	To what extent do you think that Misty is competent?
4	To what extent do you think that Misty is responsible?

Number	Perceived Robot Attractiveness Scale Item
1	How attractive is Misty?
2	How hot is Misty?
3	How sophisticated is Misty?
4	How sexy is Misty?
5	How innovative is Misty?
6	How thought-provoking is Misty?

Number	Desire for Companionship Scale Item
1	To what extent do you want Misty to keep you company during stressful events, such as a dental treatment and or a difficult test?
2	To what extent do you want Misty to keep you company when you are alone?

Question wording: Please rate the following statements. The perceived robot attractiveness survey used a seven-point scale from Not at all to Very Much and the rest of the surveys used a five-point scale from Not at all to Very Much. **Note:** These scale items were adapted from the first study of the two studies conducted in Birnbaum et al. [41]. Specifically, we changed the robot's name to Misty for all scale items.

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