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ABSTRACT

23 Interpersonal coordination is important for many joint activities. A special case of
24 interpersonal coordination is synchronization, which is required for the performance of many
25 activities, but is also associated with diverse positive social and emotional attributes. The
26 extent to which these effects are due to the reliance on synchrony for task performance or to
27 its temporal aspects, is not clear. To address these questions, we considered a more general
28 form of interpersonal coordination, implemented during joint artmaking. This is a non-typical
29 context for interpersonal coordination, not required for task success, and smoother and more
30 loosely-structured than more standard forms of synchronous coordination. Therefore,
31 comparing interpersonal coordination with non-coordination during shared painting, could
32 help reveal general social-emotional reactions to coordination. To gain a more 'naïve'
33 perspective we focused on children, and staged coordinated and non-coordinated art
34 interactions between an adult and a child, and asked child observers to judge various
35 variables reflecting the perceived bond between the painters. We found an overall stronger
36 perceived bond for the coordination condition. These results demonstrate that even a non-
37 typical form of interpersonal coordination could be attributed with positive social and
38 emotional qualities, a capacity revealed already in childhood, with possible implications for
39 development.

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41 Keywords: interpersonal synchrony; coordination; joint painting; children; social interaction;
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INTRODUCTION

Many human activities are performed collaboratively. Such interactions often involve coordinated movements between interacting individuals. A special and well-studied case of interpersonal coordination is synchrony, whereby the coordinated movements are very strictly matched in time. This occurs during various joint activities ranging from simply walking together^[1] or engaging in a conversation^[2] to rowing as a team^[3] or playing in an orchestra^[4]. In many cases, interpersonal synchronization is a basic requisite for the successful accomplishment of the joint activity. For example, for players in the same string section within an orchestra to produce coherent music, the individual bow movements must be continuously aligned in space and time.

Beyond such a practical role of synchronous coordination in enabling the basic execution of joint action, it has been discovered that the very experience of interpersonal synchrony appears to positively impact interacting individuals both socially and emotionally, further enhancing the quality of the interaction and even subsequent interactions^[5-8]. These effects include enhanced feelings of belonging^[9], mutual understanding and fondness^[10], empathy^[11], and deepened comprehension of the emotional intentions of the synchronized collaborator^[12]. Synchrony experience may also promote trust^[13], influence the memory of the interpersonal interaction^[14], and improve subsequent cooperation between interacting adults^[14] as well as children^[15].

Interestingly, even external observers witnessing other individuals engaging in synchronous interpersonal interaction, readily attribute to these individuals increased rapport^[10,16] entitativity^[16-17], affiliation^[18] and empathy^[19]. These perceived effects of synchrony reveal how deeply ingrained is the notion of interpersonal synchrony and its associations with positive social and emotional interaction. Thus, external impressions of observed interpersonal synchronous interactions can provide a useful readout of the coordinated experience.

The focus on the social and emotional impact of interpersonal synchronous coordination has mostly addressed discrete and punctuated forms of interaction, as often occurs in real life. This common type of coordination is characterized by uniformly interspersed distinct units of movement, such as tapping^[9], rocking^[20], and swinging^[15,21]. In contrast, much less is known about smooth, irregular forms of interpersonal coordination, and their impact on interacting individuals. Such smooth and non-rhythmic movements may occur, for example, during artistic activities, such as painting. Although painting is typically an individualistic activity, it can be performed jointly, for instance, during group art lessons or in an art therapy context^[22]. Interpersonal coordination during joint painting presents two unique features. First, it offers an opportunity to explore less structured forms of interaction, and to thus generalize the impact of synchrony experience to more general aspects of coordination. Second, the nature of the activity itself is improvisatory, has no defined purpose, and is open-ended, unlike, for example, rowing or rocking, which are highly defined, or playing a written piece of music together. As such the intentions of the interacting individuals are fluid and the entire interaction is dynamic and open to interpretation. The combination of both the smoothness and improvisatory nature of the interaction provides a unique context for the embodiment of interpersonal coordination. Thus, the social-emotional effects linked to synchronous interpersonal coordination can be dissociated from its functional and defined role in enabling the basic performance of the joint activity.

91 In another study that is currently under consideration, we have found that joint painting
 92 activity by two adults is perceived by external observers to be of higher quality when the
 93 painting movements are coordinated between the two painters compared to non-coordinated
 94 movements. This finding suggests that the perception of interpersonal coordination is much
 95 more general than previously thought, encompassing discrete and smooth forms of
 96 synchrony. Interestingly, a similar judgement of quality was made also by children observing
 97 the interaction, suggesting that the broad positive connotations of coordinated interaction are
 98 established already in early age. To better understand how interpersonal coordination is
 99 perceived by children, we sought in the current study to examine detailed aspects of how
 100 children judge five different aspects of joint artmaking: empathy, trust, closeness, similarity,
 101 and quality of interaction.

102 Previous work has demonstrated a capacity for synchronous interpersonal coordination
 103 experience to enhance each one of these social and emotional aspects of interaction. As
 104 described, synchronization has been shown to improve the understanding of other people's
 105 emotional intentions^[23], as well as increase the ability to experience compassion and exhibit
 106 altruistic behavior^[24], which together may underlie enhanced *empathy*^[12,25]. Synchronization
 107 can effectively increase *trust* among individuals sharing a synchronized experience^[13].
 108 Synchronization raises mutual understanding and fondness, enhancing perceived
 109 *closeness*^[10,16,26] and *similarity*^[26]. We thus hypothesized that these effects should generalize
 110 to the smoother and subtler form of coordination introduced during joint painting, and be
 111 recognized by child observers. This, and our preceding study that is currently under
 112 consideration, are the first to explore the perception of interpersonal coordination in children.

113

114

MATERIALS AND METHODS

115 **Participants**

116 Participants were typically developing 9-11-year-old children, with an average age of 10.4
 117 years (SD=0.9). Parents were recruited to the study through ads that were posted on social
 118 media by the researchers (i.e., convenience sampling) and through parents of previous
 119 participants (i.e., snowball sampling). Altogether 20 boys (33%) and 41 girls (67%)
 120 participated by completing an online questionnaire that included closed-ended questions.
 121 Additional eight participants did not complete the questionnaire and as such, their responses
 122 were omitted from the study.

123 The study was initially conducted in Hebrew, but due to difficulties in recruiting a sufficient
 124 number of participants, it was translated into English, enabling the participation of additional
 125 participants from the USA and Australia. The Hebrew version of the questionnaire was
 126 completed by 53 participants from Israel (87%). The English version was completed by eight
 127 participants (13%), including four from Australia, two from the USA, and two from Israel
 128 who preferred to respond in English.

129 **Procedure**

130 Parents of prospective participants were asked to access the Calendly (<https://calendly.com>)
 131 appointment scheduling software to choose a convenient date and time to conduct a
 132 telephone conversation with the researchers. At the appointed time, one of the researchers
 133 contacted the parents by telephone to provide an in-depth explanation of the study. The
 134 researcher double-checked the child's age, and explained that the research will be conducted
 135 online and anonymously, and will consist of two short videos followed by a closed-ended
 136 questionnaire. The researchers provided also further instructions about how the questionnaire
 137 should be completed. At the end of the telephone conversation the researcher sent the parents

138 a link to the online questionnaire via Qualtrics (<https://www.qualtrics.com>) online software.
 139 This program was used for gathering the research data.

140 Once the link was opened, the parents were first asked to give their informed written consent
 141 for their child's participation in the study and to indicate the birth date and gender of their
 142 child. Next, the child was asked to work independently, without the assistance of family or
 143 friends. They were asked to view two short 90-second videos prepared by the researchers and
 144 to then fill in a questionnaire. As soon as the child finished filling in the questionnaire, the
 145 parents were asked to provide written feedback regarding the procedure of the study and
 146 whether there were any special events that occurred while the child was participating in the
 147 study, and submit the questionnaire.

148 **Research Material**

149 Videos

150 We prepared two videos of a woman and a 6-year old girl engaging in a shared hand painting
 151 process (**Fig. 1**; video excerpts are included in the Supplemental Material). Each video lasted
 152 1 minute and 40 seconds and showed one of two women (named Kara or Jackie in the
 153 English version, and Tal or Shani in the Hebrew version) interacting with one of two girls
 154 (named Tara or Becky in the English version, and Gal or Adi in the Hebrew version). In the
 155 coordination procedure, the woman adjusted her hand movements to match those of her
 156 young drawing partner. In the non-coordination procedure, the woman did not do so. A
 157 counterbalance was introduced between the woman-girl pairs so that half of the participants
 158 viewed Kara and Tara perform the coordination procedure, and Jackie and Becky perform the
 159 non-coordination procedure, and for the other half the pairs were swapped with regard to
 160 coordination/non-coordination. The two videos were presented to the participants in a
 161 random order.



162
 163 **Fig. 1.** (A) A snapshot from the coordinated joint painting video. (B) A snapshot from the non-coordinated joint
 164 painting excerpt.

165 Movement analysis of the interaction

166 To analyze movements during joint painting, video data were extracted and filtered by a
 167 video-based 2-D motion analysis system Kinovea® 0.8.27. Semi-automatic object tracking
 168 allowed us to measure distance and velocity, and to export data files for further analysis^[27,28].
 169 We manually selected a region of interest (ROI) around the middle finger of the right hand of
 170 each performer, and a 2D movement was then semi-automatically tracked. We applied grid-
 171 based calibration as a coordinate system, enabling measurements in the plane of motion not
 172 aligned with the camera.

173 First, we calculated the distance in the x and the y-axis (centimeters) versus time
 174 (seconds). We plotted the distance in the y-axis (centimeters) versus time (**Fig. 2 A-B**). Then
 175 we conducted linear cross-correlation analysis, which provides a measure of overall
 176 coordination between participants using the Matlab xcorr function (Mathworks, Natick, MA,
 177 USA), at lags $k = 0, \pm 1, \pm 2, \dots, \pm 20$ sec For data pairs. (see^[29-30]). The corresponding position

178 components were uncorrelated for values close to 0, while values close to 1 indicate that the
 179 position components were correlated (see **Fig. 2 C-D**).

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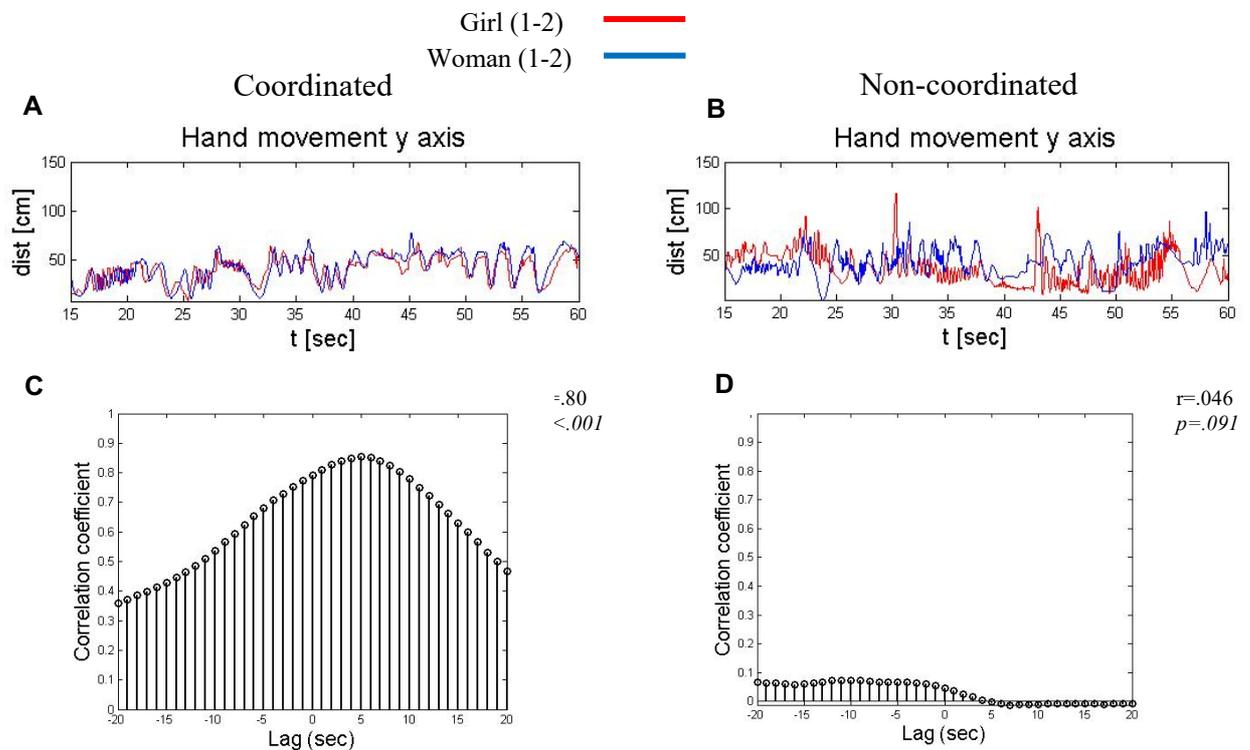
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198 **Fig. 2.** (A) Coordinated Right-hand movement on the y-axis for coordinated condition throughout video
 199 recording for girl and woman. The peak occurs after a 5 sec lag, the girl is guiding the movement (B) Non-
 200 coordinated Right-hand movement on the y-axis for the non-coordinated condition throughout the video
 201 recording for girl and woman. (C) Cross-correlation between movement on the y-axis for coordinated condition.
 202 (D) Cross-correlation between movement on the y-axis for non-coordinated condition.

203 Questionnaire

204 After watching the two videos, the participants were asked to complete a 15-item
 205 questionnaire. These were divided into 5 sections relating to the five dependent variables
 206 examined in the study: empathy, trust, closeness, similarity, and quality of interaction. The
 207 language and format of each item were adjusted to suit children. The closed-ended answers
 208 were presented in writing and through illustrations. All questionnaire items were adapted
 209 from various previously validated studies, as detailed below. The English version of the
 210 questionnaire is included in the Supplemental Material.

211 **Empathy.** Four questions were taken from the 17-item Empathic Resonance Scale
 212 questionnaire^[31] and adapted to children. For example, “Which researcher had a better
 213 understanding of what the young girl felt and thought?” The answers included gradual
 214 comparative scales with four options, such as: (a) Kara did, much more than Jackie; (b) Kara
 215 did, slightly more than Jackie; (c) Jackie did, much more than Kara; and (d) Jackie did,
 216 slightly more than Kara. In each question, preference for the researcher in the coordinated
 217 painting video was rated 1, while preference for the researcher in the non-coordinated
 218 painting video was rated 0. A one-sided binomial test was then conducted for a 50%
 219 proportion. In addition, an overall perceived empathy score was calculated by averaging the
 220 individual question scores for each participant. The hypothesis was examined through a one-
 221 sided Wilcoxon signed ranks test that compared the median to 0.5.

222 *Trust.* A single item was presented based on the Harris and Corriveau^[32] model for examining
 223 young children's selective trust. Participants were shown pictures of the two women
 224 protagonists from the videos, each linked to a quote attributed to that woman about the shared
 225 activity. The participants were asked to choose which of the two sentences is correct in their
 226 opinion. The two sentences, however, had the same meaning: "Painting is a fun activity" and
 227 "Painting is an enjoyable activity". According to the model, when children are confronted
 228 with a conflict in choice, they will choose the statement presented by the person who they
 229 perceive to be more trustworthy. A preference for the woman who appeared in the
 230 coordination video was rated 1, while a preference for the other woman was rated 0. A one-
 231 sided binomial test was conducted for a 50% proportion.

232 *Closeness.* Two questions were presented based on the Inclusion of Other in the Self (IOS)
 233 Scale by Aron et al.^[33], and its previous implementation^[26]. The item included six pairs of
 234 circles. For each pair, the two circles were positioned at decreasing distances from one
 235 another (from far away to complete merging). The questionnaire was adapted to third person
 236 singular, and the circles contained the names of the woman and her young partner.
 237 Participants were asked to mark the pair of circles that most resembles the closeness between
 238 the adult and the child in the coordinated drawing, and then to mark the pair of circles that
 239 most resembles the closeness of the two in the non-coordinated drawing. These two questions
 240 were presented to participants in a random order. To calculate the difference in closeness
 241 between the two types of drawing, the coordination score was subtracted from the non-
 242 coordination score. The differences, which ranged from -5 to 5, were converted into scores
 243 between 0 and 1. For example, if the two pairs were given the same score for closeness, this
 244 would result in a difference of 0, to be transformed to 0.5 on the converted scale. A one-sided
 245 Wilcoxon signed ranks test was conducted to compare the median to 0.5.

246 *Similarity.* A self-reporting questionnaire for measuring similarity^[26] was employed. This
 247 questionnaire was designed to examine the degree of perceived similarity between children
 248 and their interacting partner, with particular emphasis on physical similarity and similarity in
 249 character and hobbies. The reliability of the original questionnaire measured by Cronbach's α
 250 was 0.73. Five out of the six questions in the original questionnaire were rephrased in the
 251 third-person singular. For example: *Which of the two pairs were more similar to each other?*
 252 The answers included gradual comparative scales with four options, such as: (a) Kara and
 253 Tara were much more similar than Jackie and Becky; (b) Kara and Tara were slightly more
 254 similar than Jackie and Becky; (c) Jackie and Becky were much more similar than Kara and
 255 Tara; and (d) Jackie and Becky were slightly more similar than Kara and Tara. For each
 256 question in this section, preference for the pair in the coordinated painting video was rated 1,
 257 whereas preference for the pair in the non-coordinated painting video was rated 0. A one-
 258 sided binomial test was conducted for a 50% proportion. As an overall score of perceived
 259 similarity, the average question score per participant was calculated. The hypothesis was
 260 examined through a one-sided Wilcoxon signed ranks test that compared the median to 0.5.

261 *Quality of interaction.* The AT-WAI Questionnaire^[34] originally developed for examining
 262 therapeutic alliance during art therapy, was employed. The reported reliability of the
 263 questionnaire (Cronbach's α) was 0.78. External validation was measured through the
 264 Pearson correlation coefficient for the bond component in the original WAI, and was $r=0.37$
 265 ($p < 0.000$). Out of this questionnaire, three questions from the *art experience* section were
 266 adapted to children and included in the present study. For example: *Which of the two girls*
 267 *enjoyed herself more while painting?* The participants were asked to choose from the
 268 following four options: (a) Tara enjoyed herself much more than Becky; (b) Tara enjoyed
 269 herself slightly more than Becky; (c) Becky enjoyed herself much more than Tara; and (d)
 270 Becky enjoyed herself slightly more than Tara. For each question in this section, preference

271 for the girl in the coordinated painting video was rated 1, while preference for the girl in the
 272 non-coordinated painting video was rated 0. A one-sided binomial test was then conducted
 273 for a 50% proportion. An overall average ranging between 0 and 1 was calculated for the
 274 entire section for each participant. The hypothesis was examined through a one-sided
 275 Wilcoxon signed ranks test that compared the median to 0.5.

276 In addition to the analysis of individual questionnaire items and sections, an overall score
 277 was derived for each participant by averaging over all section scores. One-Sided Paired T-
 278 tests were conducted to compare this score's average to 0.5.

279 Addressing possible confounds

280 In order to examine whether participants may have had a distinct preference (i.e., bias) for
 281 one of the adults in the videos, or for one of the adult-child pairs, statistical analyses were
 282 conducted comparing the scores for each dependent variable between the two adult-child
 283 pairs, regardless of the coordination or non-coordination condition. Wilcoxon ranks sum tests
 284 for independent samples were conducted for the empathy, closeness, similarity, and quality
 285 of interaction measures, and a Chi-Square test for independent samples was performed for the
 286 trust section.

287 To examine whether the age or gender of participants affected the results, the participants
 288 were divided according to age (above vs. below 10.5 years) or gender (boys vs. girls). Here
 289 too, Wilcoxon ranks sum tests for independent samples were conducted for the empathy,
 290 closeness, similarity, and quality of interaction measures, and a Chi-Square test for
 291 independent samples was performed for the trust section.

292 **Ethics**

293 Following the introductory telephone conversation between the parent and the researcher, the
 294 parent was asked to sign a written informed consent form via Qualtrics. Moreover, the
 295 researcher emphasized that the child is not obligated to participate in the study and may stop
 296 their participation at any stage. Anonymity was ensured by separating the list with identifiers
 297 from the data files and keeping the results in a locked, password protected file. This study,
 298 which is part of a larger research project, was approved by the Ethics Committee at the
 299 University of Haifa (approval #354/20). We confirm that all research was performed in
 300 accordance with relevant guidelines/regulations, and that informed consent was obtained
 301 from all participants and/or their legal guardians. Informed consent for publication of
 302 identifying information/images in an online open-access publication was granted from the
 303 adult and child experimenters.

304

305

305 RESULTS

306 The responses of child participants to videos showing a woman and girl painting together in
 307 coordination vs. non-coordination (**Fig. 1**) were examined along the five main dimensions of
 308 the study: empathy, trust, closeness, similarity, and quality of interaction. Participants
 309 perceived the two interactions differently with respect to four out of the five dependent
 310 variables measured (**Fig. 3**).

311 *Empathy.* As hypothesized, participants perceived the adult engaged in coordinated painting
 312 as more empathetic than the adult performing non-coordinated painting. This was indicated
 313 by an overall averaged empathy score with an observed median of 0.75 ($p < .001$), and a
 314 significantly higher than 0.5 rating of each individual question (**Table 1**).

315

316 **Table 1** Empathy section results

Question	Observed Proportion	Test Statistic (Z)	1-sided Significance
Who better understood the child's painting?	.89	6.02	<.001
Who better understood what the child felt and thought?	.67	2.69	.004
Who was more attentive to the child?	.90	6.27	<.001
Who was more interested in the child's painting?	.77	4.48	<.001

317

318 *Trust*. The hypothesis whereby the participants would perceive the adult in the coordinated
 319 art activity as more trustworthy was not supported (observed proportion=0.46, $p=0.739$).

320 *Closeness*. As hypothesized, participants perceived the adult and child in the coordinated
 321 interaction as being *closer* one to the other with an observed median of 0.70 ($p<.001$).

322 *Similarity*. As hypothesized, the adult and child in the coordinated art activity were perceived
 323 as being more *similar* one to the other compared to the pair in the non-coordinated activity,
 324 as indicated by the averaged similarity score (Observed median=0.60, $p<.001$). Specifically,
 325 four out of the five questions that composed this overall similarity measure showed a
 326 significantly higher than 0.5 rating (**Table 2**).

327

328 **Table 2** Similarity section results

Question	Observed Proportion	Test Statistic (Z)	1-sided Significance
Which pair generally looks more similar?	.56	0.90	.185
Which pair has more common interests?	.67	2.69	.004
Which adult reminds you more of the child she paints with?	.64	2.18	.015
Which adult is more similar in character to the child she paints with?	.66	2.43	.008
Which adult likes similar painting styles to the ones the child she paints with?	.75	3.97	<.001

329

330 *Quality of interaction*. As hypothesized, the quality of the interpersonal interaction between
 331 the adult and child engaged in coordinated joint painting was perceived as better and more
 332 enjoyable compared to the non-coordinated condition, as indicated by the averaged observed
 333 median of 0.67 ($p=0.017$). In particular, three out of the four questions in this section
 334 received scores that were significantly higher than 0.5 (**Table 3**).

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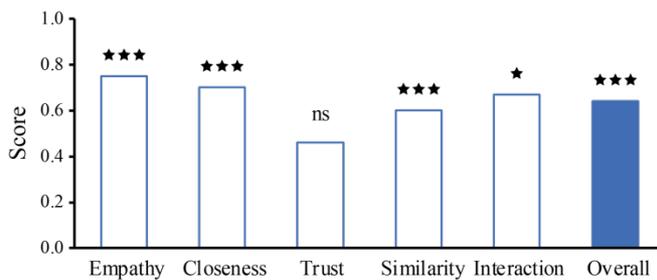
336 **Table 3** Quality of interaction section results

Question	Observed Proportion	Test Statistic (Z)	1-sided Significance
Which child was more comfortable with the painting activity?	.67	2.69	.004

Which child felt freer during the painting activity?	.49	-0.13	.551
Which child enjoyed the painting activity more?	.62	1.92	.027

337

338 In summary, four of the five specific hypotheses were supported by the results (**Fig. 3**). In
 339 addition, the five measures were combined into one general variable relating to the overall
 340 perceived emotional bond between the adult and child in the painting activities. At this
 341 general level as well, the coordinated activity was perceived as reflecting a better emotional
 342 bond between the adult and child compared to the non-coordinated one (observed
 343 mean=0.64, $p<0.001$; **Fig. 3**).



344

345 **Fig. 3.** Summary of results

346

347 To address the possibility of confounds due to an inherent preference for one of the two
 348 adults or adult-child pairs in the videos, participant responses were reordered according to the
 349 protagonists in the videos, ignoring whether they had engaged in a coordinated or non-
 350 coordinated joint painting interaction. No preference was found for a particular adult-child
 351 pair (**Table 4**).

352

353 **Table 4** Data rearranged to compare between one adult-child pair and the other

Section	Test Statistic (Z)	2-sided Significance
Empathy	-0.07	.943
Closeness	-1.93	.053
Trust*	2.32	.127
Similarity	0.86	.389
Interaction	-1.16	.246

354 *For the Trust measure the test statistic was χ^2 and not Z.

355 To probe a possible age or gender effect, responses were once more reordered, this time
 356 according to age (above vs. below 10.5 years) and then gender (boys vs. girls). Here too, no
 357 significant relationship was found between the participants' age (**Table 5**) or gender (**Table**
 358 **6**) and the choices made by the participants.

359

360

361 **Table 5** Data rearranged to compare between responses of participants under vs. over 10.5 years of age

	Under 10.5			Over 10.5			<i>p</i>
	<i>M</i>	<i>SD</i>	Median	<i>M</i>	<i>SD</i>	Median	
Empathy	0.78	0.22	0.75	0.84	0.22	1.00	.219
Similarity	0.71	0.27	0.80	0.60	0.25	0.60	.061
Interaction	0.53	0.30	0.67	0.67	0.38	0.67	.406
Closeness	0.66	0.18	0.70	0.65	0.19	0.70	.889
Trust	0.48	0.51	0.00	0.43	0.50	0.00	.692
Overall	0.63	0.14	0.63	0.64	0.20	0.65	.813

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363

364 **Table 6** Data rearranged to compare between boy and girl participant responses

	Boys			Girls			<i>p</i>
	<i>M</i>	<i>SD</i>	Median	<i>M</i>	<i>SD</i>	Median	
Empathy	0.83	0.22	1.00	0.80	0.23	0.75	.745
Similarity	0.66	0.28	0.70	0.65	0.25	0.60	.881
Interaction	0.53	0.37	0.67	0.63	0.33	0.67	.736
Closeness	0.67	0.19	0.70	0.65	0.18	0.70	.736
Trust	0.55	0.51	1.00	0.41	0.50	0.00	.319
Overall	0.65	0.20	0.64	0.63	0.16	0.63	.501

365

366

DISCUSSION

367 We have found that children observing an adult and child dyad painting together in a
 368 coordinated manner tend to perceive the painters as more empathic, more similar and closer
 369 to one another, compared to when they paint without particular coordination. In general, the
 370 children tended to judge the quality of the coordinated interaction to be better than the non-
 371 coordinated interaction. These results demonstrate the broad impact attributed to
 372 interpersonal coordination, even in the context of visual arts, which is not regularly
 373 associated with coordination between individuals. In particular, the enhanced social and
 374 emotional bonding perceived to exist between the interacting individuals, was evident despite
 375 the smooth and irregular form of coordination employed, which substantially differs from the
 376 standard discrete and rhythmic interaction considered in most previous work on synchronous
 377 interpersonal coordination. Our findings demonstrate that such a predisposition to identify
 378 even loosely-structured coordination within an interaction, and to judge it as indicative of
 379 social-emotional bonding, exists already in children and as such may play an important role
 380 during development.

381 Unlike music, which is rhythmically organized along the time dimension, and is often
 382 performed by a group, requiring synchronization between players, visual art, such as
 383 painting, is usually static, extending over space rather than time, and is typically created by a

384 single individual. Nevertheless, a painting may still arouse in the observer physical and
385 emotional sensations of the gestures and movements of the artist who had created it, even
386 without actually seeing that artist in action^[35]. Indeed, the notion of the observer blending in
387 with the work of art, and internally imitating the motions and emotions embedded within it,
388 was the initial inspiration for the concept of empathy, originally characterized by Lipps in the
389 19th century using the German term *Einfühlung*^[36]. In the current study we took a step back
390 and focused not on the finished piece of art but on the process of creating it, directly
391 considering the painters' actions. The joint painting provided a unique context of a
392 coordinated interaction that is not typically associated with synchrony and does not require
393 synchrony for its successful accomplishment. These features, made it possible to dissociate
394 the net effects of coordination from other factors such as the timing-dependent or
395 independent nature of the activity and the necessary conditions for its performance, and to
396 generalize the notion of interpersonal coordination to the visual arts, thus opening new
397 avenues for considering art-based interpersonal interactions.

398 In particular, interpersonal coordination in the visual arts may have specific implications for
399 visual art therapy. Previous work has demonstrated how coordination in the form of
400 synchronization may impact various other forms of therapy, including psychotherapy, music
401 therapy, and drama therapy, enhancing the quality of the therapeutic bond^[12,37]. In analogy,
402 during art therapy sessions, shared client-therapist artwork is sometimes applied as a means
403 of familiarization and evaluation^[22,38]. One of the most familiar tools is Winnicott's Squiggle
404 Game, aimed at creating an initial "interview" with child clients during therapy^[39]. Joint
405 drawing and painting are also used to enhance the therapeutic bond and improve the
406 therapist's understanding of the client^[40-41]. Our results suggest that enhancing coordination
407 during shared squigglings or painting may strengthen the foundations of the therapeutic
408 alliance. This direction should be further explored in future work.

409 According to our findings, study participants perceived the adult in the coordinated painting
410 condition as having a better understanding of the young girl's painting and of her thoughts
411 and feelings. The adult was also perceived as being more attentive towards the young girl and
412 more interested in her painting. It is likely that watching the pair work in coordination led the
413 participants to feel that a state of empathy, understanding, and mutual language exists
414 between the two, whereby one's hand movements are familiar, understood, and learned by
415 the other, through means of observation and attention. Thus, coordination could be
416 interpreted by the observers either as the outcome of preexisting empathy or as its inducer.

417 The current research hypothesized that the participants would perceive the adult in the
418 coordinated painting condition as more trustworthy, yet the findings did not support this. The
419 reason for this may stem from the method used for assessing trust. As described in the
420 Methods section, participants had to choose between two dissimilarly phrased, but
421 synonymous quotes attributed to the coordinating vs. non-coordinating adults ("Painting is a
422 fun activity" and "Painting is an enjoyable activity"). Based on previous studies^[32], the
423 rationale was that when asked to select which of the two quotes was more correct, the child
424 observers would select the phrase attributed to the adult they deemed more trustworthy.
425 However, no bias in favor of the synchronized adult was found, even though previous studies
426 had showed synchronous interpersonal coordination to be linked to trust^[13,42]. It is likely that
427 the difference in phrasing between the two adult quotes were too subtle, possibly creating
428 confusion rather than conflict among the participants. It seems unlikely that trustworthiness is
429 associated only with synchronous coordination, and not with coordination, in general. Future
430 studies could benefit from implementing a different type of measurement for examining this
431 relationship, and clarifying the results.

432 With regards to *closeness*, the findings of this study indicate that the adult-child pair in the
433 shared coordinated painting activity were perceived as being closer to one another compared
434 to the pair in the non-coordinated activity. These findings are in line with previous studies
435 whereby synchronous coordination between two individuals were shown to impact feelings
436 of closeness between the pair^[18-19]. Studies have also shown the reciprocal effect, whereby an
437 increased feeling of closeness between random pairs is accompanied by an increase in
438 interpersonal synchronized behavior^[43]. In relation to the perceived closeness between people
439 who are not directly connected, studies have shown that when participants observe
440 synchronized people, they maintain certain beliefs about why these people are synchronized.
441 One such belief is that people who move together do so because they share emotions or
442 feelings of belonging and closeness^[9,16]. Miles et al.^[10], for example, examined the degree of
443 mutual understanding and fondness between pairs who walked side by side but with different
444 degrees of synchronization, as perceived by the observing participants. The findings showed
445 that greater synchronization in walking was associated with greater perceived closeness. Our
446 current results suggest that perhaps underlying this effect is the increase in coordination,
447 which may stem, in the case of synchrony, from a better rhythmic match. Future studies
448 could therefore benefit from examining shared painting activities with varying degrees of
449 coordination.

450
451 The fourth element examined in this study relates to *perceived similarity*. Our findings show
452 that the child participants perceived the similarity between the pair in the coordinated activity
453 as greater than between the pair in the non-coordinated one. This is consistent with previous
454 studies, which found that children and adults who participated in a synchronized
455 interpersonal interaction with random partners, perceived the similarity between themselves
456 and their partners as greater than those who participated in an asynchronous activity^[26,44-45].
457 Such results were found also in a study, in which the participants observed (but did not
458 participate in) the interactions of pairs who moved in synchronization and pairs who did
459 not^[16].

460
461 Meltzoff^[46] found that infants tend to imitate adult behavior, which leads them to feel similar
462 to the imitated adult. This feeling among infants extends beyond the physical similarity of
463 their behavior or movements to also include similarities in their interpretation of the other
464 person's psychological situations, such as perceptions and emotions. Meltzoff coined this
465 type of representation as "Like Me" and viewed this as the starting point of social cognition.
466 Similarly in the current study, the participants perceived the adult and child in the shared
467 coordinated procedure as more similar to one another in their personalities, hobbies, and
468 types of preferred paintings. They also perceived the adult as resembling her young drawing
469 partner. This perceived similarity may stem from the perception extending beyond the
470 similarity of movements to also include personal similarities. In other words, if the adult-
471 child pair painted in a coordinated manner, then perhaps they were perceived as having
472 additional similar traits as well, such as looks, personality, and hobbies.

473
474 Finally, the current study found that the quality of the *interpersonal interaction* between the
475 adult and child in the coordinated painting activity as better and more fun and the overall
476 score of social and emotional bonding showed a clear preference for the coordination
477 condition.

478
479 In summary, this study supports the claim that shared coordinated painting is perceived by
480 child participants to be associated with greater empathy, closeness, similarity, and quality of
481 the interaction when compared to non-coordinated joint painting. The study is unique as it

482 examines these components within the context of art, specifically in relation to shared visual
 483 art activities. Similar to creating intentional synchronized moments during music, drama, and
 484 movement, coordination between painters could also play a potential role in interpersonal
 485 activities based on visual art. Moreover, although the current study focused on how shared
 486 coordinated painting activities are perceived by observers, not by the activity of the
 487 participants themselves, the findings have important implications; they emphasize how
 488 readily interpersonal coordination can be discerned, and show the extent of its influence even
 489 at the perceptual level, of merely observing an interaction without being part of it. In
 490 particular, the study shows that even relatively young children perceive coordinated and non-
 491 coordinated activities differently.

492

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REFERENCES

1. Zivotofsky, A. Z., Gruendlinger, L., & Hausdorff, J. M. Modality-specific communication enabling gait synchronization during over-ground side-by-side walking. *Hum. Mov. Sci.* **31**, 1268-1285 (2012).
2. Tolins, J., Zeamer, C., & Fox Tree, J. E. Overhearing dialogues and monologues: How does entrainment lead to more comprehensible referring expressions?, *Discourse Process.* **55**, 545-565 (2018).
3. Cohen, E. E., Ejsmond-Frey, R., Knight, N., & Dunbar, R. I. Rowers' high: behavioural synchrony is correlated with elevated pain thresholds. *Biol. Lett.* **6**, 106-108, (2010).
4. Fadiga, L., Tokay, S., & D'Ausilio, A. Interaction, Cooperation and Entrainment in Music: Experience and Perspectives. In *Space-Time Geometries for Motion and Perception in the Brain and the Arts* (Eds. Flash, T. & Bertoz, A.) 213-233 (Springer, Cham, 2021).
5. Cross, L., Turgeon, M., & Atherton, G. How moving together binds us together: The social consequences of interpersonal entrainment and group processes. *Open Psychol.* **1**, 273-302 (2019).
6. Mogan, R., Fischer, R., & Bulbulia, J. A. To be in synchrony or not? A meta-analysis of synchrony's effects on behavior, perception, cognition and affect. *J. Exp. Soc. Psychol.* **72**, 13-20 (2017).
7. Rennung, M., & Göritz, A. S. Prosocial consequences of interpersonal synchrony. *Z Psychol.* **224**, 168-189 (2016).
8. Vicaria, I. M., & Dickens, L. Meta-analyses of the intra-and interpersonal outcomes of interpersonal coordination. *J. Nonverbal Behav.* **40**, 335-361 (2016).
9. Hove, M. J., & Risen, J. L. It's all in the timing: Interpersonal synchrony increases affiliation. *Soc. Cogn.* **27**, 949-960 (2009).
10. Miles, L. K., Nind, L. K., & Macrae, C. N. The rhythm of rapport: Interpersonal synchrony and social perception. *J. Exp. Soc. Psychol.* **45**, 585-589 (2009).
11. Behrends, A., Müller, S., & Dziobek, I. Moving in and out of synchrony: A concept for a new intervention fostering empathy through interactional movement and dance. *Arts Psychother.* **39**, 107-116 (2012).
12. McGarry, L. M., & Russo, F. A. Mirroring in dance/movement therapy: Potential mechanisms behind empathy enhancement. *Arts Psychother.* **38**, 178-184 (2011).

13. Launay, J., Dean, R. T., & Bailes, F. Synchronization can influence trust following virtual interaction. *Exp. Psychol.* **60**, 53-63 (2013).
14. Miles, L. K., Griffiths, J. L., Richardson, M. J., & Macrae, C. N. Too late to coordinate: Contextual influences on behavioral synchrony. *Eur. J. Soc. Psychol.* **40**, 52-60 (2010).
15. Rabinowitch, T. C., & Meltzoff, A. N. Synchronized movement experience enhances peer cooperation in preschool children. *J. Exp. Child Psychol.* **160**, 21-32 (2017a).
16. Lakens, D., & Stel, M. If they move in sync, they must feel in sync: Movement synchrony leads to attributions of rapport and entitativity. *Soc. Cogn.* **29**, 1-14 (2011).
17. Lakens, D. Movement synchrony and perceived entitativity. *J. Exp. Soc. Psychol.* **46**, 701-708 (2010).
18. Cacioppo, S. et al. You are in sync with me: Neural correlates of interpersonal synchrony with a partner. *Neuroscience.* **277**, 842-858 (2014).
19. Koehne, S., Hatri, A., Cacioppo, J. T., & Dziobek, I. Perceived interpersonal synchrony increases empathy: insights from autism spectrum disorder. *Cognition.* **146**, 8-15 (2016).
20. Richardson, D., Dale, R., & Shockley, K. Synchrony and swing in conversation: Coordination, temporal dynamics, and communication. In *Embodied Communication in Humans and Machines* (Eds. Watchsmuth, I. Lenzen, M. & Knoblich, G.) 75-94 (Oxford University Press, 2008).
21. Rabinowitch, T. C., & Meltzoff, A. N. Joint rhythmic movement increases 4-year-old children's prosocial sharing and fairness toward peers. *Front. Psychol.* **8**, 1050 (2017b).
22. Gavron, T., & Maysseless, O. Creating art together as a transformative process in parent-child relations: The therapeutic aspects of the joint painting procedure. *Front. Psychol.* **9**, 2154 (2018).
23. Koole, S. L., & Tschacher, W. Synchrony in psychotherapy: A review and an integrative framework for the therapeutic alliance. *Front. Psychol.* **7**, 862 (2016).
24. Valdesolo, P., & DeSteno, D. Synchrony and the social tuning of compassion. *Emotion.* **11**, 262 (2011).
25. Eisenberg, N., Shea, C. L., Carlo, G., & Knight, G. P. Empathy-related responding and cognition: A "chicken and the egg" dilemma. In *Handbook of Moral Behavior and Development Vol. 2* (Eds. Kurtines W. N. & Gewirtz J. L.) 85-110 (Psychology Press, 2014).
26. Rabinowitch, T. C., & Knafo-Noam, A. Synchronous rhythmic interaction enhances children's perceived similarity and closeness towards each other. *PloS one.* **10**, e0120878 (2015).
27. Bamford, J. M. S., & Davidson, J. W. Trait Empathy associated with Agreeableness and rhythmic entrainment in a spontaneous movement to music task: Preliminary exploratory investigations. *Music. Sci.* **23**, 5-24 (2019).
28. Kim, J. H., Han, J. K., & Han, D. H. Training effects of Interactive Metronome® on golf performance and brain activity in professional woman golf players. *Hum. Mov. Sci.* **61**, 63-71 (2018).
29. Shumway, R. H. and Stoffer, D. S. ARIMA models, *Time Series Analysis and Its Applications (with R Examples)*, 2nd ed. (New York: Springer, 2011).
30. Box, G. E. P., Jenkins, G. M., and Reinsel, G. C. *Time Series Analysis, Forecasting and Control*, 2nd ed. (New York: Prentice-Hall, 1994).
31. Saunders, S. M., Howard, K. I., & Orlinsky, D. E. The Therapeutic Bond Scales: Psychometric characteristics and relationship to treatment effectiveness. *Psychol. Asses.: A J. Consult Clin. Psychol.* **1**, 323 (1989).

32. Harris, P. L., & Corriveau, K. H. Young children's selective trust in informants. *Philos. Trans. R. Soc. Lond., B, Biol. Sci.* **366**, 1179-1187 (2011).
33. Aron, A., Aron, E. N., & Smollan, D. Inclusion of other in the self scale and the structure of interpersonal closeness. *J. Pers. Soc. Psychol.* **63**, 596 (1992).
34. Bat Or, M., & Zilcha-Mano, S. The art therapy working alliance inventory: The development of a measure. *Int. J. Art Ther.* **24**, 76-87 (2019).
35. Freedberg, D., & Gallese, V. Motion, emotion and empathy in esthetic experience. *Trends Cogn. Sci.* **11**, 197-203 (2007).
36. Wispé, L. The distinction between sympathy and empathy: to call forth a concept, a word is needed. *J. Pers. Soc. Psychol.* **50**, 314-321 (1986).
37. Ramseyer, F., & Tschacher, W. Nonverbal synchrony in psychotherapy: coordinated body movement reflects relationship quality and outcome. *J. Consult. Clin. Psychol.* **79**, 284 (2011).
38. Lavey-Khan, S., & Reddick, D. Painting together: A parent-child dyadic art therapy group. *Arts Psychother.* **70**, 101687, (2020).
39. Abram, J. *The language of Winnicott: A dictionary of Winnicott's use of words.* (Routledge, 2018).
40. Blekofer, C.M., Nolan, E. Practical applications of neuroscience in art therapy: A holistic approach to treating trauma in children. In *Art Therapy, Trauma, and Neuroscience* (Ed. King, J.L.) 177-192 (Routledge, 2016).
41. Furneaux-Blick, S. Painting together: how joint activity reinforces the therapeutic relationship with a young person with learning disabilities. *Int. J. Art Ther.* **24**, 169-180 (2019).
42. Lang, M., Bahna, V., Shaver, J. H., Reddish, P., & Xygalatas, D. Sync to link: Endorphin-mediated synchrony effects on cooperation. *Biol. Psychol.* **127**, 191-197 (2017).
43. Vacharkulksemsuk, T., & Fredrickson, B. L. Strangers in sync: Achieving embodied rapport through shared movements. *J. Exp. Soc. Psychol.* **48**, 399-402 (2012).
44. Reddish, P., Fischer, R., & Bulbulia, J. Let's dance together: synchrony, shared intentionality and cooperation. *PloS one*, **8**, e71182 (2013).
45. Valdesolo, P., Ouyang, J., & DeSteno, D. The rhythm of joint action: Synchrony promotes cooperative ability. *Journal of Experimental Social Psychology.* **46**, 693-695 (2010).
46. Meltzoff, A. N. 'Like me': A foundation for social cognition. *Dev. Sci.* **10**, 126-134 (2007).

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499

500 **AUTHOR CONTRIBUTIONS**

501 R.A. and T.C.R. conceptualized the experiment and wrote the original manuscript. R.A.
 502 performed the experiment. R.A., N.G. and T.C.R. analyzed the data. All the authors
 503 participated in reviewing and editing the manuscript.

504

505 **DATA AVAILABILITY STATEMENT**

506 Data generated during this study are available at [this link](#) and has also been submitted as part
 507 of the Supplemental Material.

508

509 **ADDITIONAL INFORMATION**

510 The authors declare no competing interests.

511

512 **FIGURE LEGENDS**

513 **Fig. 1.** (A) A snapshot from the coordinated joint painting video. (B) A snapshot from the
514 non-coordinated joint painting excerpt.

515 **Fig. 2.** (A) Coordinated Right-hand movement on the y-axis for coordinated condition
516 throughout video recording for girl and woman. The peak occurs after a 5 sec lag. the girl is
517 guiding the movement (B). Non-coordinated Right-hand movement on the y-axis for the non-
518 coordinated condition throughout the video recording for girl and woman. (C) Cross-
519 correlation between movement on the y-axis for coordinated condition. (D) Cross-correlation
520 between movement on the y-axis for non-coordinated condition.

521 **Fig. 3.** Summary of results

522

523 **TABLE LEGENDS**

524 **Table 1** Empathy section results

525 **Table 2** Similarity section results

526 **Table 3** Quality of interaction section results

527 **Table 4** Data rearranged to compare between one adult-child pair and the other

528 **Table 5** Data rearranged to compare between responses of participants under vs. over 10.5
529 years of age

530 **Table 6** Data rearranged to compare between boy and girl participant responses

531

532

533

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