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1 Do conversational agents have a theory of mind? A single case 2 study of ChatGPT with the Hinting, False Beliefs and False 3 Photographs, and Strange Stories paradigms.

4
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19 **Keywords: conversational agents, ChatGPT, theory-of-mind, indirect speech, False**
20 **Beliefs**

21 22 Abstract

23 In this short report we consider the possible manifestation of theory-of-mind skills by the
24 recently proposed OpenAI's ChatGPT conversational agent. To tap into these skills, we used
25 an indirect speech understanding task, the hinting task, and a new text version of a False
26 Belief/False Photographs paradigm, and the Strange Stories paradigm. The hinting task is
27 usually used to assess individuals with autism or schizophrenia by requesting them to infer
28 hidden intentions from short conversations involving two characters. Our results show that the
29 artificial model has quite limited performances on the Hinting task when either original scoring
30 or revised SCOPE's rating scales are used. To better understand this limitation, we introduced
31 slightly modified versions of the hinting task in which either cues about the presence of a
32 communicative intention were added or a specific question about the character's intentions
33 were asked. Only the latter demonstrated enhanced performances. In addition, the use of a False
34 Belief/False Photographs paradigm to assess belief attribution skills demonstrates that
35 ChatGPT keeps track of successive physical states of the world and may refer to a character's
36 erroneous expectations about the world. No dissociation between the conditions was found.
37 The Strange Stories were associated with correct performances but we could not be sure that
38 the algorithm had no prior knowledge of it. These findings suggest that ChatGPT may answer
39 about a character's intentions or beliefs when the question focuses on these mental states, but
40 does not use such references spontaneously on a regular basis. This may guide AI designers to
41 improve inference models by privileging mental states concepts in order to help chatbots
42 having more natural conversations. This work offers an illustration of the possible application
43 of psychological constructs and paradigms to a cognitive entity of a radically new nature, which

44 leads to a reflection on the experimental methods that should in the future propose evaluation
45 tools designed to allow the comparison of human performances and strategies with those of the
46 machine.

47 1 Introduction

48 Having a theory of mind can be conceived as the capacity to understand and predict the
49 behavior of others or of oneself by using mental concepts such as intentions, beliefs,
50 knowledge, etc. In the present work, we address the possibility of applying these concepts and
51 some available paradigms to new artificial intelligence (AI) technologies, considered as a
52 cognitive agent, and highlight their potential contributions in the addressed areas. Historically,
53 the concept was coined to investigate animals like chimpanzees (Premack and Woodruff 1978),
54 and was successful to study early child development (Baillargeon, Scott, and He 2010) and
55 pathological conditions like autism (Baron-Cohen, Leslie, and Frith 1985). To determine if an
56 individual has a theory-of-mind (ToM) it is necessary to analyze his/her behavior, interactions
57 with congeners in experimental conditions that require the use of these skills. These different
58 conditions are associated with either the absence of language or with non-proficient
59 communication skills, and lead to the design of varieties of nonverbal paradigms. However,
60 the existence of articulate language and the ability to conduct conversations and process
61 complex requests makes it seemingly easy to detect theory of mind abilities in the individual.
62 Firstly, the use of mental state terms or concepts (i.e., “I believe”, “she thinks”, “he wants”,
63 “they seek to” etc.) can be considered as a proof of the conceptual capacity to attribute
64 volitional or epistemic mental states to another one. Secondly, language is part of a pragmatic
65 context of communication. It has long been conceptualized that our ability to communicate is
66 largely based on the building of a shared knowledge with the interlocutor and that deciphering
67 indirect or metaphorical language requires the understanding of the communicative intention
68 of interlocutors (Sperber and Wilson 1986). Precisely about these notions, authors have
69 proposed to test the theory of mind through the comprehension of indirect language in the sense
70 that it requires to make assumptions about the underlying intentions.

71
72 It was shown that patients with schizophrenia suffering from communication and/or social
73 cognition disorders present deficits in the comprehension of indirect speech. Widely replicated
74 and validated experimental paradigms have been proposed to measure the deficit of patients
75 and to measure their pragmatic skills. Here, we consider the hinting task introduced by
76 Corcoran et al (1995). This task was designed to test the ability of subjects to infer the real
77 intentions behind indirect speech utterances. The task consists of ten short stories presenting
78 an interaction between two characters in which one character drops a very obvious hint.
79 Allowing to detect deficits in schizophrenia, the task was selected by the SCOPE initiative to
80 create a social cognition assessment battery (Pinkham, Harvey, and Penn 2018). More recently
81 norms in healthy subjects and schizophrenic patients were published with both the original
82 scoring system and a new one proposed to improve psychometric properties by lowering ceiling
83 effects (Klein et al. 2020). In the following study, we will consider both criteria to score a
84 subject’s performance.

85
86 Older than the hinting task, the attribution of epistemic mental states, namely beliefs and
87 knowledge, could be tested through the so-called False Belief paradigm (Baron-Cohen, Leslie,
88 and Frith 1985; Wimmer 1983). In its classical version, two dolls, Ann and Sally, are involved
89 in a short sequence in which one of them moves an object after the other one had left the scene.

90 The task is to figure out that the second character will look for the object in the place she left
91 it and not where it actually is. This task was regularly posed as a gold standard to attest the
92 presence or deficiency of a first-order theory of mind (i.e., inferences about another's mental
93 state) and different versions have been proposed in order to distinguish a capacity for
94 mentalization from a simple memorization of the actual state at a specific moment in history.
95 The False Photographs task is one of them and includes a description very close to the False
96 Beliefs paradigm but is not based on the erroneous mental state of the character and provides
97 a task structure of similar complexity (Zaitchik 1990). Last, we focused in this work on Happé's
98 Strange Stories task which is another paradigm allowing to test mental and physical inference
99 skills from short texts. This task was initially developed for studying children with autism
100 (Happé 1994).

101

102 In the field of artificial intelligence, the development of conversational agents has recently
103 made striking progress allowing these models to produce responses that compete with human
104 responses. These agents are disembodied and “purely linguistic” by nature. If computer
105 linguistic agents have more and more sophisticated communication capacities, their internal
106 architectures do not necessarily include models of mental states. In what follows, we
107 investigate whether methods of assessments of pathological ToM in humans can be applied to
108 a conversational agent. We have chosen to focus on the recently proposed ChatGPT model¹,
109 which is the state of the art in this field. It is based on multiple steps fine-tuning of a transformer
110 based architecture with reinforcement learning for human feedback and the use of large scale
111 conversation datasets (see reviews of generative models in (see reviews of generative models
112 in Gozalo-Brizuela and Garrido-Merchan 2023). This model brought a lot of attention because
113 it has extremely impressive skills to produce sound and well-formulated answers to a wide
114 range of questions: its' differences with human experts has been recently questioned (Guo et
115 al. 2023, 202). The use of deep learning techniques based on training over massive databases,
116 makes it particularly complicated to answer the question of the existence, at least implicitly, of
117 mental concepts represented within very complex, poorly interpretable structures. It is
118 interesting to note that the interpretability of deep-learning models, i.e., the fact that they may
119 be understood by humans, is a complex question with legal, societal and ethical consequences
120 (Carvalho, Pereira, and Cardoso 2019), and that it may be considered as sharing some logics
121 with neurosciences' objectives of understanding brain computations and discovering neural
122 codes.

123

124 According to Mortensen's investigation of ChatGPT's social skills, the chatbot did not consider
125 it had a ToM while it knew some about the concept (2023). To provide further investigations
126 about its skills, like a single clinical case study, we confronted this artificial agent with several
127 measures of ToM. Using standardized ratings issued from psychopathological research, we
128 report some quantitative measures of ChatGPT performances and some insights to improve
129 them by adding different cues or specific instructions. Following an exploratory approach,
130 when it appeared relevant, we slightly modified the tasks in order to investigate the AI's skills

¹ OpenAI, ChatGPT: Optimizing language models for dialogue, <https://openai.com/blog/chatgpt/> (November 30, 2022). To access the web-based chat: <https://chat.openai.com/chat>

131 by measuring performance improvement when specific cues were added. In these cases, we
132 investigated changes in the wording of the questions to see the extent to which their focus on
133 the characters' intentional states or expectations might alter the accuracy of the responses.

134 2 Methods

135 2.1 Hinting task

136 Free online ChatGPT (Dec 15th 2023 version) was interrogated with a series of questions from
137 the hinting task. For a subpart of the following procedure subsequent test sessions were
138 conducted with the Jan 09th and 30th versions. In its original version, this task designed to
139 assess patients with schizophrenia consists of ten situations described by three sentences
140 involving two characters (Corcoran, Mercer, and Frith 1995). In each situation, one protagonist
141 says something that may be indirectly interpreted as a request toward the other character.

142

143 Example: George arrives in Angela's office after a long and hot journey down the
144 motorway. Angela immediately begins to talk about some business ideas. George
145 interrupts Angela saying: "My, my! It was a long, hot journey down that motorway!"

146

147 Invariably, a question is asked "What does the character [here George] really mean when he
148 says this?", in order to test the chatbot or the human subject's capability to infer a
149 communicative intention.

150 The expected answers (here "Can I have a drink" and/or "Can I have a few minutes to settle
151 down after my journey before we start talking business") is rewarded by 2 points (HINTING
152 1 scores).

153

154 In the absence of a correct answer, a second version (HINTING 2) with an additional cue is
155 tested:

156

157 Example (following): George arrives in Angela's office after a long and hot journey
158 down the motorway. Angela immediately begins to talk about some business ideas.
159 George interrupts Angela saying: "My, my! It was a long, hot journey down that
160 motorway!" George goes on to say: "I'm parched!" What does George want Angela to
161 do?

162

163 If respondents clarify the subjects' intention ("George wants Angela to get him or offer to get
164 him a drink."), they score one-point.

165

166 The text responses were rated independently by two of the authors (EBG and NV) according
167 to specific and validated criteria (HINTING 1+2). Between each sentence the chatbot's history
168 was erased so that no context could be used. Three scoring systems were used in order to
169 compare the model's skills with those of healthy or individuals with schizophrenia, and with
170 the models' itself. The first one is the version described by Corcoran et al. (1995), the second

171 one is a revised version from the SCOPE initiative by Klein et al. (Klein et al. 2020). The third
172 scoring system is simply the number of correct answers to the HINTING 1 and the HINTING
173 2 questions, allowing us to compare the scores with the two conditions described below.
174

175 In order to investigate ChatGPT's errors when it deals with intentional situations, two other
176 versions of the sentences were used. These modifications were made in an exploratory
177 approach based on the observed errors in order to reveal the sensitivity of the model to the
178 pragmatic aspects of the questions:

179 1. Character's Intention version (INJUNCTION): the three sentences as described above
180 (HINTING 1) are kept and the question from the second part of the task (HINTING 2)
181 is added without the additional cue. This experimental condition thus clarifies the
182 question by indicating that one character expects something from the other. However,
183 no information is added to the context. Thus, performances can be compared with that
184 of HINTING 1.

185
186 Example: George arrives in Angela's office after a long and hot journey down
187 the motorway. Angela immediately begins to talk about some business ideas. George
188 interrupts Angela saying: "My, my! It was a long, hot journey down that motorway!"
189 What does George want Angela to do?

190
191 2. Communicative intention version (COMMUNICATIVE): In this version the question
192 of the original version (HINTING 1) was modified and indicated explicitly that a
193 character likely had a "communicative intention". This version allowed us to test
194 whether the chatbot could use this concept to urge an inference about the character's
195 intention. The fact that ChatGPT understood the term "communicative intention" was
196 verified with a direct interrogation².

197
198 Example: George arrives in Angela's office after a long and hot journey down
199 the motorway. Angela immediately begins to talk about some business ideas. George
200 interrupts Angela saying: "My, my! It was a long, hot journey down that motorway!"
201 Considering George's most likely communicative intention, what does he really mean
202 when he says this?

203 2.2 False beliefs and False photographs task

204 The version proposed here of the False Belief and False Photograph tasks was designed
205 specifically to test the capabilities of ChatGPT. The test was performed twice to check the
206 answer's coherence. It involves a description of a classic initial situation with two protagonists

² The concept of communicative intention is accurately defined by ChatGPT when asked for:

Question (Jan 30th): What is a communicative intention?

ChatGPT: Communicative intention refers to the purpose or goal that a speaker has in mind when producing an utterance or message. It refers to the intended message or information that the speaker wants to convey to the listener. Communicative intentions can vary widely, from providing information, making requests, giving advice, making a joke, persuading someone, etc. Understanding the communicative intention behind an utterance is crucial in effective communication and in building social relationships.

207 in a kitchen, Alan and Jenny, the latter placing her chocolate in the cupboard. The object
208 transfer sequence was made more complex than in the classical versions and was declined in
209 several versions (two False Beliefs situations) in order to make sure that the model does not
210 respond randomly based on the probability of the usual presence of chocolates in cupboards.

211

212 The question is asked in two ways. Indeed, it appeared depending on the formulation, ChatGPT
213 could answer very differently to the questions leading either to success or failure:

- 214 ● In the LOOK condition, the question is about where Jenny will look for the chocolate
215 when she returns.

216

217 Example: Alan and Jenny are in the kitchen. Jenny puts her chocolate inside the
218 cupboard. Then, she leaves the kitchen. Alan moves the chocolate to the table, and then
219 he moves it to the fridge, and moves it again to the table. Later, Jenny comes back to
220 the kitchen to eat her chocolate. Where will Jenny look to find it ?

221

- 222 ● In the EXPECT condition, the question is about where Jenny expects to find her
223 chocolate, introducing an interrogation about the mental state.

224

225 Example: Alan and Jenny are in the kitchen. Jenny puts her chocolate inside the
226 cupboard. Then, she leaves the kitchen. Alan moves the chocolate to the table, and then
227 he moves it to the fridge, and moves it again to the table. Later, Jenny comes back to
228 the kitchen to eat her chocolate. Where will Jenny expect to find it?

229

230 Finally, the task of the False Photographs (PHOTO) highlights an inconsistency between the
231 state of the real world at the end of the story and that described by a photograph taken before
232 Alan's chocolate transfer sequence.

233

234 Example: Alan and Jenny are in the kitchen. Jenny puts her chocolate inside the
235 cupboard. Then, she takes a photograph of the kitchen. Alan moves the chocolate to the
236 table, and then he moves it to the fridge, and moves it again to the table. Later, Jenny
237 looks at the photograph she took. Where are the chocolates in the photograph?

238 2.3 Strange stories mental and physical task

239

240 In this task, the ChatGPT is required to interpret short vignettes and is asked to explain why a
241 character says something that is not literally true (White et al. 2009). To succeed it has to
242 attribute mental states such as desires, beliefs or intentions, and sometimes higher order mental
243 states such as one character's belief about what another character knows. Scoring system ranges
244 from 0 to 2 points for each story depending on the quality of the interpretation. In addition, two
245 conditions of equal difficulty are presented: MENTAL and PHYSICAL, the former focusing
246 on mental state attributions and the second on physical states only.

247

248 Example: (MENTAL) Simon is a big liar. Simon’s brother Jim knows this, he knows
249 that Simon never tells the truth! Now yesterday Simon stole Jim’s ping-pong paddle,
250 and Jim knows Simon has hidden it somewhere, though he can’t find it. He’s very cross.
251 So he finds Simon and he says, “Where is my ping-pong paddle? You must have hidden
252 it either in the cupboard or under your bed, because I’ve looked everywhere else. Where
253 is it, in the cupboard or under your bed”? Simon tells him the paddle is under his bed.
254 Why will Jim look in the cupboard for the paddle?

255 3 Results

256 Please note that all the results of the evaluations are available in the Supplementary Material.

257 3.1 Hinting task

258 In all cases and conditions, ChatGPT was able to give a detailed answer from one to five
259 sentences. In the majority of the cases, it provided several hypotheses, which often included
260 the correct answer. In some cases, ChatGPT qualified its answers by expressing doubts (“It is
261 difficult to say for certain”, “It is not clear from the information provided...”) or even
262 incertitude (“It’s not possible for me to accurately determine the true meaning behind Rebecca’s
263 statement.”). These utterances give, at least, the appearance of the existence of some kind of
264 metacognitive judgment. It also gives to the reader the impression that one preponderant answer
265 strategy is based on a reformulation of the questions that does not require much inference skills.
266 However, in many cases it appears that ChatGPT is able to conclude and even produces some
267 intentional hypotheses as shown below. The scores obtained by ChatGPT given the conditions
268 and the rating systems are reported in Table 1. Answers and quotations are reported in
269 Supplementary Material.

270
271 ChatGPT performs poorly at the first question of the task (HINTING 1) with a number of
272 correct answers between 1 and 4 on a total of 10 questions. However, this score is largely
273 improved in the second part of the task when a cue and a question about the character’s
274 demands is asked (HINTING 2). Indeed, more questions are answered correctly, raising the
275 score to 8 or 9 on 10. Even if this improvement is significant, the use of Corcoran’s and Klein’s
276 rating systems show that the overall performances (HINTING 1+2) remain low respectively at
277 10/20 and 7 to 9/20. Let’s remember that Corcoran’s and Klein’s control subjects performed at
278 17.9/20 (SD=2) and 16/10 (SD=2.5), respectively, and that the patients with schizophrenia
279 scored 15.7/20 (SD=3.4) and 13.7/20 (SD=3.4). In all cases, ChatGPT performed worse than
280 human subjects.

281
282 Compared to the HINTING 2 condition, INJUNCTION allowed ChatGPT to give 6 or 8 correct
283 answers out of 10, while COMMUNICATIVE only reached a score of 4/10.

284 3.2 False beliefs and False photographs task

285 The conversational agent exhibits perfect performances at the False Beliefs task in the
286 EXPECT condition and at the False Photographs task (see Table 2). On the contrary the LOOK
287 condition is failed at the exception of one item when the chocolate is returned to its initial place.
288 We scored this answer as zero because the justification was wrong.

289 3.3 Strange stories mental and physical task

290 ChatGPT answered quite correctly to both MENTAL and PHYSICAL conditions in the
291 Strange Stories task (see Table 3) when the scoring system described in White et al. (2009) was
292 used.

293 4 Discussion

294 Detecting and evaluating manifestations of intentional reasoning and more generally of a
295 theory of mind in an individual is a complex task that has given rise to numerous research and
296 methodological proposals. In this paper, we investigate the ability of a recent and extremely
297 sophisticated model of conversational agent, OpenAI's ChatGPT, to use intentional reasoning
298 to understand ambiguous language. To do so, we simply confronted the chatbot with items
299 from well-known tasks that are standard in research on mentalization. If this simple
300 implementation of a single case methodology cannot by itself solve the question of the presence
301 of a form of theory of mind in natural language processing models, the analysis of the results
302 reveals some intriguing and important methodological questions for the future. It should also
303 be noted that our approach was deliberately observational, as in clinical investigations of single
304 cases. Indeed, we do not use, in our analysis, any knowledge of the information processing
305 mechanisms or computations used by ChatGPT to generate responses. We considered
306 ChatGPT like we would have done for a human subject. We used simple scoring grids already
307 defined in clinical research to observe the quality of the responses.

308
309 The first observation of the experiment is the amazing quality of the answers given by
310 ChatGPT. They are correctly organized, and present a dialectical effort to discuss several
311 hypotheses. Of importance, characters' names and roles are preserved in the answers. Our
312 results concur with Guo et al.'s findings that this model provides "organized" with clear logic"
313 answers which tend to be "long" and "detailed" (2023). However, such answers would not
314 match the natural answers of human subjects unless they were urged to discuss all hypotheses
315 and their probabilities. These rather long and hesitant answers could appear as a way to avoid
316 answering, an obsessive indecision or a smokescreen strategy.

317
318 Second, the quantification of the quality of intentional inferences in the hinting task with the
319 criteria defined by Corcoran et al. (1995) or Klein et al. (2020) demonstrates a weak use of this
320 logic by ChatGPT. The scores obtained in both the initial and secondary questions do not
321 compete with human performances even in psychopathological conditions. This result could

322 totally exclude ChatGPT from being considered as having intentional mental states inferential
323 skills.

324

325 However, a more careful analysis of the responses shows that when the model receives
326 additional cues and more focused questions about the intention of the characters it significantly
327 improves its responses. For 8 or 9 questions out of 10, in the HINTING 2 set, the correct answer
328 is provided which is largely favorable even if it only results in a modest score with the classical
329 score formula.

330

331 Additional experiments with the modified hinting task provide further insight into the factors
332 that can help ChatGPT to respond correctly. First of all, adding (COMMUNICATIVE
333 condition) a cue prior to the question and directing the model to consider the most likely
334 communicative intention does not seem to improve the responses (score from 2 to 4/10).

335

336 A greater gain (scores of 6 or 8/10) although intermediate with the HINTING 2 condition is
337 found when it is clearly specified that the question is about what the character issuing the
338 indirect message wants their interlocutor to do (INJUNCTION), in the absence of any other
339 cue. This result suggests that this key question directs the answer to the mentalist concept and
340 allows the inference of an intentional mental state. In this case, ChatGPT uses “X wants Y to”,
341 “X asks Y to”, or “X would like Y to” to specify the intention. Thus, we find that some
342 questions allow the language model to provide responses that encompass the intentions
343 normally presented in simple life situations. However, it has a heavy tendency to stay “strictly
344 focused on the given question” as noted by Guo et al. (2023).

345

346 Regarding the False Belief paradigm, the results are also contrasted and depend directly on the
347 questions asked. We notice that ChatGPT has real capacities to exploit complex sequences of
348 information indicating successive actions and even taking into account representations of a
349 changing reality. The False Photographs task allows the model to demonstrate this clearly
350 because it brings, in certain answers, logical reasoning about the changes of objects’ state (i.e.
351 position of the chocolate) contrasting with the static state of the photograph:

352

353 Example: ChatGPT: “The chocolates would be in the cupboard on the photograph that
354 Jenny took, as that is where she put them before taking the photograph and Alan moved
355 them after she took it”).

356

357 Similarly, we note in the case of False Beliefs an ability to take into account the knowledge of
358 one of the characters to anticipate what she expects. Jenny will expect to find her chocolate in
359 the cupboard, as that is where she put it before leaving the kitchen. Surprisingly, sometimes
360 emotional elements appear concerning the possible reaction of the character in the absence of
361 the object in the expected place.

362

363 Example: ChatGPT: “She may be surprised or confused to find it in the fridge or on the
364 table”.

365

366 Let us note the failure of the model in the LOOK condition. In our case, this type of question
367 seems to induce the necessity for the model to answer to the final position of the object and not
368 to the position anticipated by Jenny. One explanation could be that ChatGPT is trying to answer
369 the literal question: where will Jenny look for the object is a question corresponding to the final
370 location of the object. But it does not infer that this question is about Jenny's expectations (her
371 mistaken beliefs) that will guide her search strategy. However, such interpretation is
372 contradicted by Mortensen's report of a correct answer in another version of Ann and Sally's
373 false belief paradigm, ending with a look question ("Where will Sally look for her marble?")
374 (2023). As indicated above, our paradigm was, on purpose, made more complex, with several
375 successive moves of the chocolate in order to dampen the success of a probability answer. It
376 appears that subtle modifications of the formulation and the situation produce changes that are
377 difficult to anticipate, sometimes allowing ChatGPT to either produce answers whose
378 argumentation indicates that it has taken into account the mental state of the character or
379 answers that are incompatible with a theory-of-mind.

380

381 Finally, the strange stories test also seems to bring positive results regarding the inference
382 capacities of the model due to impressive performances. Such a level of performance is
383 unexpected given the complexity of the stories (their length) compared to the simple situations
384 used in the hinting task. It is possible, however, that these longer, more detailed contexts (often
385 8 sentences) and explicitly dealing with mental states such as the characters' beliefs urges
386 ChatGPT to use theory of mind concepts. However, as discussed below, in the limitations of
387 the study, ChatGPT could have been exposed to the data on this task (logics, situations, etc.)
388 during the learning procedure. It is therefore difficult for us to integrate the results of the
389 Strange Stories task in our conclusions. This emphasizes the needs for the creation of large-
390 scale test corpora and the design of theory of mind task generators to test models on
391 unpublished sets of situations or stories.

392

393 All these results raise deeper questions in philosophy of mind that go beyond the scope of our
394 article. It appears from the experiments shown here that, under certain prompting conditions,
395 ChatGPT responds by referring to some mental concepts. According to this perspective it
396 would be possible to say that it uses knowledge of intentional logic regularities to produce a
397 verbal description of certain expected behaviors. Again, we don't say that this form of
398 intentional stance (Dennett 1987) is modularized or even explicitly introduced in the design of
399 ChatGPT, by analogy to the question of the neural embedding of theory of mind in humans,
400 i.e. the so-called social brain (Brothers 1990). Non-domain-specific and implicit computational
401 mechanisms may be at work as part of the encoding and decoding mechanisms of the
402 transformer. These have been set up by the lengthy training procedure which brought into light
403 regularities at a lexical and semantic levels, but without a modular implementation of a stable
404 and independent representations of characters' mental states. In that sense, it is unlikely that
405 ChatGPT January 2023 version, while responding appropriately to first-order intentions and
406 beliefs, would be able to generalize this stance to social situations it never met, and be
407 considered as a full theory-of-mind agent.

408 5 Limitations of the study

409 The present study is obviously insufficient to clarify the question of the existence of a theory
410 of mind in a computer model. The small number of items makes it difficult to draw a conclusion
411 without being able to produce a statistical inference by repeating test trials. A longer procedure
412 would be needed to test the model studied on multiple occasions. We note, however, that the
413 small number of trials corresponds to the usual conditions for the use of tests in clinical
414 practice. It is interesting that the sophistication of ChatGPT allowed us to consider it as a usual
415 human subject.

416

417 Let's also note that successive versions of ChatGPT may produce changes in measured
418 performances. Based on that, we conducted the assessment on two successive versions
419 (December 2022 and January 2023), and we found only slight differences that may be partly
420 related to some stochastic parts in the model.

421

422 Finally, we are not aware of the possible contamination of answers by the succession of
423 questions we asked. Eliminating the question history does not guarantee a perfect reset of the
424 response system (at least if we consider ChatGPT as a human being). Moreover, ChatGPT's
425 large learning base could include the data and knowledge gathered about the tasks we used. A
426 direct questioning of ChatGPT about the hinting task does not seem to reveal any particular
427 knowledge of the task or its authors while it acknowledges that it could be useful!³ On the
428 contrary, the Happé's Strange Stories task is clearly referred to by ChatGPT as a well-known
429 paradigm used to study social cognition deficits in autism.⁴ When investigating ChatGPT's
430 knowledge on these tasks, it provides intriguing answers:

431

432 Question: Can you give an example of the Strange Stories task used to study autism?

³ *Question* (Jan 06th version): What do you know about the hinting task?

ChatGPT: "The hinting task is a task that involves providing hints or clues to help a user or system solve a problem or accomplish a goal. This can include providing suggestions for the next steps in a task, providing additional information to help clarify a question or problem, or providing feedback on the progress of a task. The specific details of a hinting task can vary depending on the application or context in which it is being used.

Question: Do you know the hinting task designed to study schizophrenic patients?

ChatGPT: I am not aware of any specific hinting task that is specifically designed to study schizophrenia in patients, but it is possible that such a task could be developed for research purposes. Schizophrenia is a complex mental disorder that affects how a person thinks, feels, and behaves. It can cause symptoms such as hallucinations, delusions, and disordered thinking. Research on schizophrenia often involves studying the cognitive processes and brain function of patients with the disorder. A hinting task could potentially be used as a tool to study these processes and to better understand how they are affected by the disorder.

⁴ *Question*: What do you know about the Strange Stories task for studying autism?

ChatGPT: The Strange Stories task is a well-known task used in research on autism spectrum disorder (ASD). It was first introduced by Simon Baron-Cohen and his colleagues in the early 2000s. The task involves presenting individuals with short written scenarios, referred to as "strange stories", which have unusual or unexpected events. Participants are then asked questions about the stories to assess their ability to understand mental states (e.g. beliefs, desires, intentions) and theory of mind. Studies using the Strange Stories task have shown that individuals with ASD tend to have difficulties understanding mental states and exhibit reduced theory of mind compared to neurotypical individuals. As a result, the task is commonly used as a diagnostic tool for assessing theory of mind and social cognition in individuals with autism.

433 ChatGPT: Sure! Here's an example of a Strange Stories task scenario: "John is looking
434 for his keys. He thinks they are in the kitchen, but they are not there. He goes to the
435 living room and finds them on the sofa." After presenting this scenario to the
436 participant, the researcher might ask questions like:

437 Where does John think his keys are?

438 Where do the keys actually end up being?

439 Where does John find his keys?

440 The answers to these questions can provide insight into the participant's ability to
441 understand John's mental states and beliefs, which is an important aspect of theory of
442 mind and social cognition. This information can then be used to better understand an
443 individual's strengths and weaknesses in these areas, and potentially inform
444 intervention plans for individuals with autism.

445

446 While not being able to source in the literature the example given by ChatGPT and ensure its
447 accuracy, it is not possible to exclude a deeper knowledge of this test by the model who may
448 have been challenged by it during its training. For the experimenter, if we consider the design
449 of tasks that can be used by both humans and machines, it will be necessary to guarantee their
450 confidentiality, particularly since the AIs may be trained on any available data, even articles in
451 scientific literature describing these same tasks.

452 6 Conclusion

453 This study challenged a recently designed conversational agent, ChatGPT, with the hinting
454 task, a classical intention reading task used to assess social cognitive skills in schizophrenia,
455 and with a new False Beliefs/False Photograph test and Strange Stories. Adopting a radical,
456 blind to technological considerations about the models' design, cognitive psycho-pathological
457 and clinical perspective, we used this task as in a single case study and proposed revised
458 versions in order to characterize the AI performances. The main finding is that some paradigms
459 classically designed for human study are applicable in conditions quite close to their use in
460 clinical or research settings. The psychological constructs that are attached to them (theory of
461 mind, attribution of beliefs or intentions, communicative intention, etc.) seem to be
462 implementable in research even though the cognitive agent being studied is of a radically new
463 nature. However, the results concur with Mortensen's note that "In a way interaction with
464 ChatGPT is unlike any other interaction we know as humans" (2023). These new cognitive
465 agents of an artificial nature are likely to challenge the double-dissociations of performance
466 found in humans that underlie neuropsychological constructs as we know them, which could
467 lead to profound revisions of conceptual frameworks in neuroscience.

468

469 As shown by the results, ChatGPT does not exhibit spontaneous and reliable use of theory-of-
470 mind inference to find the most likely interpretation of hints in simple conversations. However,
471 in certain conditions, when the question focuses on people's intentions, the conversational
472 model produces correct interpretations with explicit and even well-argued references to mental
473 states and improves its scores. Arguably, some capabilities to "infer" first-order mental states

474 exist but seem not to be favored by the model. In addition, some False Belief attribution and
475 complex dynamic representation of the world exists. Yet, sometimes these skills are not
476 manifested and concrete answers without taking into account epistemic mental states are
477 prioritized. In addition, further investigation of higher order mental states attributions (i.e.,
478 beliefs about another one's beliefs) should be conducted.

479

480 Whatever the technology in use, if ChatGPT was a human patient suffering from poor
481 pragmatic skills, one would recommend training it on corpuses containing numerous dialogues
482 or conversations between two or more characters based on hints and beliefs. In addition, it
483 would be interesting rewarding answers involving two agents and containing mental state terms
484 like intentional (X wants that Y, X wishes that Y, etc.) or epistemic verbs (X thinks that Y, to
485 believe, to know, etc.). Based on such a reinforcement, it could be that the algorithm produces
486 more natural answers and adopts preferentially an intentional stance like humans do.

487 7 Conflicts of interest

488 The authors declare that the research was conducted in the absence of any commercial or
489 financial relationships that could be construed as a potential conflict of interest.

490 8 Author contributions

491 EBG and NV did the assessments. EBG wrote the first draft of the manuscript which was
492 corrected and commented by all the authors.

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497

498 **Tables**

499 Table 1: ChatGPT scores at the hinting task and modified versions.

Conditions	ChatGPT version	Rating system	Rater 1	Rater 2
HINTING 1+2 trial 1	dec 15	Corcoran rating system (max = 20)	10	10
HINTING 1+2 trial 1	dec 15	Klein rating system (max = 20)	7	9
HINTING 1 trial 1	dec 15	Number of correct answers (max = 10)	2	-
trial 2	jan 09	Number of correct answers (max = 10)	4	-
trial 3	jan 09	Number of correct answers (max = 10)	2	-
trial 4	jan 30	Number of correct answers (max = 10)	1	-
HINTING 2 trial 1	dec 15	Number of correct answers (max = 10)	8	-
trial 2	jan 09	Number of correct answers (max = 10)	8	-
trial 3	jan 09	Number of correct answers (max = 10)	9	-
trial 4	jan 30	Number of correct answers (max = 10)	8	-
INJUNCTION trial 1	dec 15	Number of correct answers (max = 10)	6	-
trial 2	jan 09	Number of correct answers (max = 10)	7	-
trial 3	jan 09	Number of correct answers (max = 10)	6	-
trial 4	jan 30	Number of correct answers (max = 10)	8	-
COMMUNICATIVE trial 1	dec 15	Number of correct answers (max = 10)	4	-
trial 2	jan 09	Number of correct answers (max = 10)	2	-
trial 3	jan 09	Number of correct answers (max = 10)	4	-
trial 4	jan 30	Number of correct answers (max = 10)	4	-

500

501

502 Table 2: ChatGPT scores at the False Belief tasks and the False Photographs task. Note that the
503 tests were performed twice and resulted in the same ratings.

Conditions	ChatGPT version	Scores
False Beliefs (LOOK) “Where will Jenny look to find it ?” trial 1	jan 09	0 on 2
trial 2	jan 09	0 on 2
False Beliefs (EXPECT) “Where will Jenny expect to find it ?” trial 1	jan 09	2 on 2
trial 2	jan 09	2 on 2
False Photographs (PHOTO) trial 1	jan 09	2 on 2
trial 2	jan 09	2 on 2

504

505

506 Table 3: ChatGPT scores at both sets of stories from the Strange Stories task. Each condition
507 consists of eight stories, scoring a maximum of two points.

Conditions	ChatGPT version	Scores
Mental stories (MENTAL)	jan 30	13 on 16
Physical stories (PHYSICAL)	jan 30	12 on 16

508

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