

# Concepts and Evaluation of Psychological Models of Empathy

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## ABSTRACT

This paper provides an overview over contemporary empathy research, including concepts and definitions as well as descriptions of empathic processes and outcomes. Based on these theoretical foundations, three different approaches to model empathy are described: a low-level computational approach, an OCC-based approach, and an empathy model inspired by PSI, a general psychological theory of psychic functioning. Ideas on how these models could be implemented in agents are discussed and preliminary efforts to evaluate the plausibility and believability of the empathic processes and outcomes are drafted.

## Categories and Subject Descriptors

D.3.3 [Programming Languages]: none

## General Terms

Theory

## Keywords

Empathy, Psychological Modeling, Evaluation

## 1. INTRODUCTION

In the field of social and emotional learning and intercultural education, virtual learning environments provide users with the opportunity for learning in a safe environment that is inhabited by emotionally expressive, autonomous agents (e.g. FearNot! [1]). Social and emotional learning with such agents is allowed for through empathic reactions in the user towards the virtual agents on the screen, a reaction that is enforced by the emotional expressivity of the agents. However, the true power of social relations towards artificial entities (such as agents in virtual worlds or as robots in the real world) can only be discovered if we manage to provide the user or learner with companions that

show interest in the user and react sensitively towards their needs and intentions, hence, that react empathically towards the user.

### 1.1 Empathy concepts and definitions

Empathy is defined by contemporary researchers as a construct that comprises two components: affective and cognitive aspects. While some researchers embrace both aspects in their empathy definitions [2,3], others emphasize either the one or the other, e.g. according to Hogan [4] "...empathy means the intellectual or imaginative apprehension of another's condition or state of mind without actually experiencing that person's feelings..." (cognitive empathy), whereas Hoffman [5] posits that "...empathy [is] a vicarious affective response to others..." (affective empathy). For the present study, we want to define empathy as an observer's understanding of the internal state of a target (cognitive empathy) as well as the observer's emotional reaction to what he/she perceives as being the internal state of a target (affective empathy).

**Cognitive empathy** means, the observer has to focus his/her attention on the target, reading expressive signals as well as situational context cues, and to try to understand – based on what he/she knows about emotional expressions in general, meanings of situations in general, and previous reactions of the target – the current reactions of the target. In general, for the empathic reaction to even start, the observer needs to be motivated and able to perceive and interpret correctly the expressive and situational cues indicating the reaction / internal state of the target. To be able to do this, the observer needs knowledge about emotional states and other reactions, how they are expressed, and what elicits them, and he/she needs to either know the target person in order to understand his/her internal state or perceive the target person as similar to themselves.

**Affective empathy** relates to the general way of how emotions emerge in a person. In the case of affective empathy, the emotions in the observer emerge due to the (conscious or unconscious) perception of internal states in a target (either emotions or thoughts and attitudes). Affective empathy thus can be the result of cognitive empathy, but can also grow out of the perception of expressive behavior that immediately transfers emotional states from one individual to another (emotional contagion). In this case, qualitatively highly similar affective states are evoked in the observer, resulting from a direct link or transfer of emotional states between individuals through verbal, para-verbal and non-verbal cues. This mechanism serves the biological function of fostering social identity and adaptation to the group, e.g. when it is vital for a herd of animals to react quickly to a predator that is only detected by one or few members of the group. In case of reactive affective empathy emerging due to cognitive (empathic) processes, a more complex conglomeration of affective states (like gloating) may result as opposed to the highly similar emotional states that result from emotional contagion.

## 1.2 Empathic processes and outcomes

Another important conceptual distinction is made between internal processes involved in empathy and the outcomes of these empathic processes. According to Davis [3], empathic outcomes have to be distinguished from processes that are “empathy-related, because they frequently occur during episodes in which an observer is exposed to a target, and because they often result in some empathy-related outcome” (p. 15). However, these processes are not specific for empathy; they occur in other contexts as well and can then also produce other but empathic outcomes. Empathic outcomes can be further divided in intra- and interpersonal. Referring to Hoffman’s developmental theory of empathy [11], Davis distinguishes between non-cognitive, simple cognitive, and advanced cognitive processes that can be involved in an empathic episode.

**Non-cognitive processes** These processes rely on the direct link between emotional states perceived in a target and the evocation of according or similar emotional states in the observer as described above. This direct, pre-reflexive and pre-verbal link can be observed very early in the human development, e.g. as “*primary circular reaction*” of newborns that cry if they perceive the crying of other infants. Also, imitation of simple expressive gestures (or *motor mimicry*) can create an according emotional state (see James / Lange theory on emotion [12]) which can be interpreted as a rudimentary form of empathy in very small children. Although empathic abilities improve with the development of cognitive abilities in the child, motor mimicry can also be part of the empathic experience in later life.

**Simple cognitive processes** Due to progressing cognitive development, more and more complex cognitive processes can add to the empathic experience. First, *classical conditioning* in a given situation or event allows for reinforcing affective reactions when the observer is simultaneously experiencing an emotion evoking situation (UCS) and an intense emotional expression of a target. The perceived emotional expression of the target can serve as a conditioned stimulus later (CS), thus leading to the activation of the emotion in the observer, even in other

situations; e.g. a toddler on her father’s arm in an emotion-arousing situation. Related to this process is *direct association*, a process of associating perceived expressive or situational cues of a target with memory representations of similar expressions or situations experienced earlier by the observer, eventually resulting in similar affective states in the target and the observer. During the very similar process of *labelling* simple representations about the meaning of situations or events are used to infer the internal state of a target experiencing this situation or event (e.g. a funeral implies for people to feel sad).

**Advanced cognitive processes** On top of the rather simple associative processes described above, associations can also be triggered by *language expressions*, e.g. witnessing a target saying “I’ve been laid off” alone suffices to trigger an understanding and maybe even the associated feeling of somebody who has been laid off (even in the absence of nonverbal gestures; this mode is working when empathizing with fictional characters, e.g. when reading a book). Also *elaborated cognitive networks* are at work when it comes to interpreting other situational cues, apart from language. Both processes rely on feelings and experiences the observer has acquired before being faced with the language or situational cues that trigger empathy. The most advanced cognitive process involved in empathy is *role-taking*, “the attempt by one individual to understand another by imagining the other’s perspective” ([3] p. 17). It involves not only associations to own feelings or experiences collected in the past, but also the effortful suppression of the egocentric perspective and the willingness to experience the situation or event explicitly from the target’s perspective. Hence, it is the only process involved in empathy that lives up to the criterion of consciously distinguishing the Self from the Other and can be regarded as the most mature and developed empathic process.

While the empathic processes can be interpreted as stages in the development of empathy, with role-taking developing latest, all processes can be part of an empathic experience in later life, e.g. processes of emotional contagion, association with memory representations and role-taking may all result in a complex and rich empathic experience within the observer. Also, the single processes may have an impact on each other. Even though there is a lack of empirical investigations into the interactions of different processes that contribute to an empathic episode, it is highly plausible to assume that more than one of them can operate simultaneously. Regarding the outcomes of the empathic processes described above, Davis distinguishes between intrapersonal and interpersonal outcomes [3]. Interpersonal outcomes can be influenced by intrapersonal empathic outcomes.

**Intrapersonal outcomes** Intrapersonal outcomes are changes in the internal state of the observer that can be either affective or non-affective. Affective outcomes are emotions that emerge in the observer, and can be either parallel or reactive in nature. *Parallel affective outcomes* produce the same or similar emotion as the emotion of the target, e.g. through motor mimicry, whereas *reactive affective outcomes* rely on associative and role-taking processes and merge with own reactions to the perceived situation and reaction of the target (the resulting affective states can be a blend of different emotions rather than an actual copy of the target emotion, e.g. personal distress, sympathy, or gloating). Non-affective outcomes are e.g. the *accuracy* with which the

observer perceives the situational and expressive cues, and the resulting quality of the assessment of thoughts, feelings, and attitudes of the target [13]. According to [3] empirical evidence suggests that similarity and familiarity between observer and target play an important role in interpersonal accuracy. Additionally, the reasons for the target's behavior that the observer attributes to the target are influenced by empathic processes: what has been termed actor-observer-difference describes the empirical finding that one usually refers to situational forces to explain one's own behavior (particularly if the behavior is not successful) while observers tend to explain the behavior of others with the help of personality characteristics or traits [14]. Empathy influences these tendencies by resulting in more *actor-like attributions* (referring to situational forces) in the observer; again, similarity, familiarity, and also sympathy or affection for the target person are additional factors that influence attribution biases apart from empathy.

**Interpersonal outcomes** Interpersonal outcomes of empathic processes relate to behavior emerging directly from the affective and/or cognitive empathic processes in the observer due to the perception of the target. The three behavioral classes described by [3] are *helping, aggression, and social behavior*.

As mentioned in the introduction, the present work aims at empathy within the agent. Three different approaches to model affective and cognitive empathy in an agent's mind are introduced: one is based on the OCC theory of emotions and its implementation within the agent architecture FAtiMA [6], one is based on PSI, a generic model of the human psychic functioning [7] [8], and one is a simple "if-then"-solution, inspired by computational approaches (this aspect of the present study represents original work, hence no reference can be provided). The three hypothetical models of empathy in agents are described in more detail in chapter 2. To evaluate these models of empathy, a text-based evaluation approach was chosen which is introduced in chapter 3: answers to four different moral dilemmas posed by readers of the weekly magazine of a German newspaper [9] have been rewritten according to a set of rules extracted from each of the three different models. The resulting expert answers to each of the moral dilemmas have been rated on a set of adjectives previously identified as measuring empathy [10].

## 2. THREE DIFFERENT APPROACHES TO MODELING EMPATHY

In this section, the three hypothetical models of empathy in agents are described in more detail. The first approach uses the OCC model of emotions [15] to model empathy. The OCC model has been selected because it is a commonly used model in computer science which considers appraisal as a subjective evaluation of a given event according to the character goals, standards and beliefs, resulting in a defined set of qualitatively different emotions (see fig. 1). Appraisals are influenced by former experiences of the organism and result in emotions that can refer to the outcomes of events, the agency of other agents or the attributes of objects. For each of them the appraisal criterion is different. Objects are appraised regarding their appealingness, agents regarding the praiseworthiness of their actions, and the outcomes (or consequences) of events are appraised regarding their desirability (see fig. 1). Desirability can be further

distinguished regarding whether the consequences of an event impact the agent itself (desirability for the self) or other agents (desirability for others). For example, when someone wins in the lottery, it is desirable for them, but won't necessarily affect others. Ortony et al. [15] posit that different appraisals lead to qualitatively different types of emotions; figure 1 outlines the appraisals and the resulting emotions for the appraisal of events. Some of these emotions can be interpreted as affective outcomes of empathic processes (happy-for, resentment, gloating and pity). The cognitive empathic processes are the appraisals of events regarding the consequences for the others.

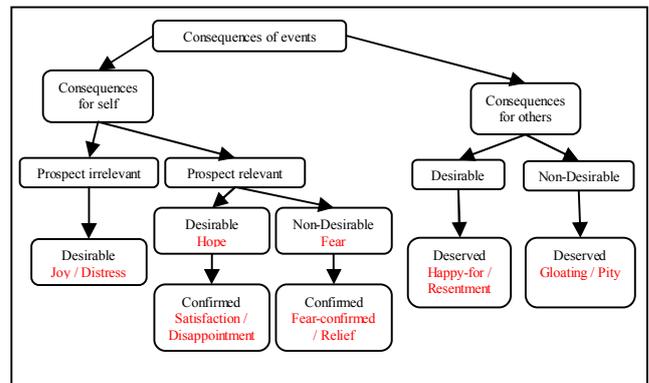
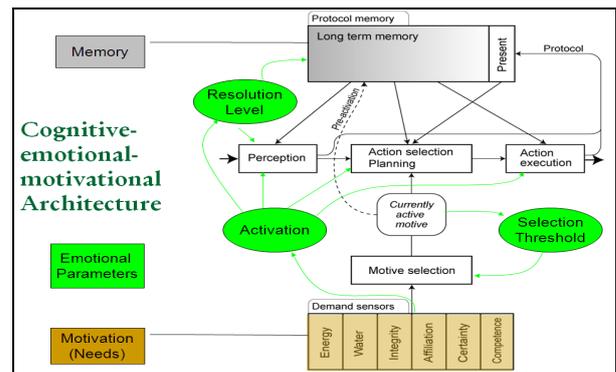


Figure 1. Example appraisals from the OCC model of emotions [15].

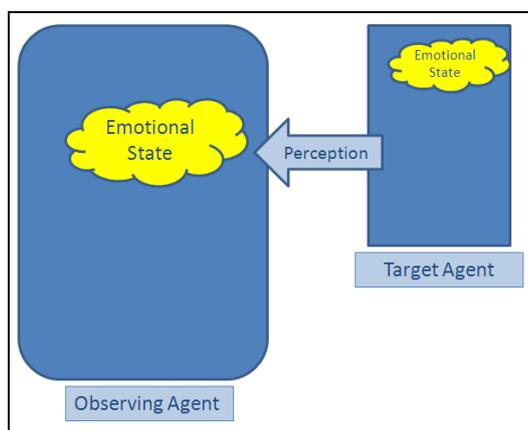
The second approach is inspired by a generic model of the human psyche [7], [8] (see fig. 2). PSI is a comprehensive and motivation-based architecture grounded in general psychology research. It allows for modeling psychic processes, integrating perception, cognition, emotion, motivation, and action within a model of human action regulation. Competing intentions are calculated from the current state of five basic needs, with their strength being influenced from the success probability derived from past experiences and the urgency of fulfilling the need. One of PSI's unique characteristics compared to other models of the human mind (e.g. [16] [17]) is the explicit incorporation of an emotional model that specifies emotions as modulations of the information processing, as inherent emergent property of cognition: emotions in PSI are specific characteristic ways in which the cognitive system works when faced with specific constellations of situational and internal (motivational) conditions.



**Figure 2: PSI model of the human psyche [7], [8].**

Thus, emotions serve as quick adaptations of the organism to a specific situation. E.g. fear is experienced under conditions that produce high need for certainty and competence and – as a result – is characterized by a high arousal level (preparedness for quick reaction), low resolution level (inaccurate perception and planning), and low selection threshold (organism is easily distracted by other cues within its environment in an attempt to detect dangers in it). It is the model of emotion that is embedded in a broad and comprehensive model of action regulation that makes the PSI approach particularly interesting when it comes to modeling empathy. Due to the “perception” of parameter settings in the other agent, a similar emotional state in the empathic agent can emerge, taking the pre-empathic state of the empathic agent into consideration (affective empathy). Knowledge about the internal state of another agent (cognitive empathy) is acquired through the model’s learning mechanism.

The third approach is a simple “if-then” computational approach, sparing computing capacity by being based on structures or processes that are already implemented or that need implementation in any case (see fig. 3). Given that the emotional states of the agents can be described by some type of “emotional parameters”, the empathic agent adopts the emotional parameters of the other agent using an attenuation factor (affective empathy). The empathic agent’s emotion resulting from the empathic process is a mixture of the two agents’ emotional states. Knowledge about the feelings of another agent in a given situation (cognitive empathy) is implemented through “if... then...”-relations. The difference to the OCC-model is that this approach specifies how information about another person’s internal states are stored in and retrieved from memory whereas the OCC model describes the actual process of “reasoning” about the internal state of another person.



**Figure 3: Low-level approach to modeling empathy.**

### 3. MODEL EVALUATION

#### 3.1 Text-based approach

It was decided to take a text-based approach to evaluate the empathic outcome of the models, i.e. we produced text-based outputs for the models in an iterative approach: First, the expert

answers by Dr. Dr. Rainer Erlinger, an expert to moral dilemmas who regularly gives advice to the readers of a weekly German magazine [9], were reviewed. Second, we carefully selected four questions from readers seeking advice that allowed for the emergence of emotions and used them as scenarios for the evaluation (cinema, hair stylist, car parking, and antenna). In the following, two examples are provided<sup>1</sup>:

“I lately went to the cinema, where only few viewers wanted to watch the movie. Shortly after the beginning of the film, a man sat down on the seat right beside me. I felt upset but didn’t have the heart to change the seat because I didn’t want to be rude. In the end, I felt angry during the whole movie. Was my behavior polite or rather foolish?” (cinema)

“One year ago, my relationship to my boyfriend ended in a terrible way, after I found out that he has been cheating on me for years. He now gave me three gift coupons for my incredibly expensive hair stylist as a birthday present. Even though I don’t have as much money as he does, I didn’t want to benefit from the voucher –because I felt too proud to do so. My hair stylist deemed me totally crazy, especially because my ex-boyfriend already had paid for the vouchers, and convinced me to use them. Now my haircut is amazing, but every time that I look in the mirror, I can’t feel happy about it. I always ask myself whether I am bribable or not. Should I maybe forfeit the remaining vouchers?”(hair stylist)

The two remaining scenarios discuss the potential dangers of a radio antenna on a family home and whether the reader should mention them to her friend who has recently moved in with her children (antenna) and the waiting inside the own car on a public car parking in the highly frequented area in front of the main station, blocking the parking space for others (car parking).

Third, two trained psychologists adapted the answers of Dr. Dr. Erlinger separately to the model conceptions outlined above. This was done by applying the empathy processes and outcomes, as specified by the respective models, to the answers the expert provided in the newspaper, thus changing them slightly and ending up with four “expert” answers for each of the four scenarios. The two psychologists then discussed their respective solutions and adapted them iteratively until they negotiated a common solution for each scenario-model-combination. These scenarios served as the pool of relevant model “behavior” for the evaluation study.

To reduce inter-model variance that was not produced by the differences between the models but by different use of language when adapting the answers, only those words and phrases of the original answer by Dr. Dr. Erlinger were changed that were directly related to empathic processes or outcomes (e.g. speculating on the thoughts and feelings of others, discussing emotions, intentions, needs, wishes, etc.); all other phrases and passages were kept identical between the adaptations of one scenario. This resulted in highly similar adaptations with only marginal variance produced by the models which is illustrated by the following answer displaying the OCC-inspired version of Dr.

<sup>1</sup> Translated into English by the authors.

Dr. Erlingers answer to the cinema scenario (original expressions in brackets):

“To ostentatiously change seats in a cinema is a bit unfriendly. However, there is no need to *feel shame* as long as the other person was unfriendly towards you. [Dr. Dr. Erlinger: „That would be justified if the other person was unfriendly towards you”]. Was this the case? In fact, the other person just chose a seat in which to sit, a right earned by purchasing the ticket. But the mere right is not what is at stake here. The problem here is one of personal space or interpersonal distance: each person has an area around themselves, marked by invisible borders which should not be violated by strangers. The classic reference in behavioral research is “The Hidden Dimension” by Edward T. Hall. Hall introduced the term “proxemics” for the study of perceived behavior in space. He distinguished between several zones, e.g. intimate zone, personal zone, and public zone. The situation in a cinema falls into the personal distance (0.45-1.20 m) which can be intruded only if both interaction partners want to be close or if there is a limited amount of space. Both conditions are not true in the present situation. Among the functions of personal space that have been discussed recently are: keeping control over one’s freedom to act and communicate, maintaining a feeling of safety (from threats or distress), and the possibility of retreat and recreation. Thus, personal space ensures a feeling of contentment which was impaired by your neighbor. Despite the apparent tranquility, he acted not just somehow strange, but *distressed you* like a true provocateur transgressing your personal boundaries [Dr. Dr. Erlinger: „...as a true provocateur attacked you with socially unacceptable behavior”]. You do not have to endure this. Faced with such insolence, it seems remarkable that you have managed to control yourself. To silently change seats is not impolite, but rather noble.”

Due to the relatively high inter-scenario similarity, three decisions were made regarding our evaluation design:

- We decided to include the original answer provided by Dr. Dr. Erlinger as a baseline.
- We decided against providing each participant of our evaluation study with all four scenarios (total workload of 16 scenarios: three adaptations plus the original answer for each of the four scenarios).
- Instead, we decided to randomly assign the 3+1 model adaptations to the scenarios and include two experimental groups with different assignments (see table 1).

**Table 1: Scenarios rated by the two experimental groups.**

Scenario	group A (N=12)	group B (N=14)
Cinema	Dr. Dr. Erlinger	OCC-inspired approach
Hair Stylist	PSI-inspired approach	Dr. Dr. Erlinger
Antenna	OCC-inspired approach	Low-level approach
Car Parking	Low-level approach	PSI-inspired approach

### 3.2 Sample and Procedure

26 subjects (21 female, aged 20 – 44 yrs., M = 26 yrs.) were asked to imagine themselves in the role of a newspaper editor who wants to hire an expert for a moral-dilemma-column such as the one in [9]. They were then exposed to four “as-if”-answers to given moral dilemmas of applicants to the job that they had to rate on a list of adjectives in order to assess their qualification for the job. For the ratings, we used a German adaptation of Davis, Luce and Kraus’ adjective list [10] to assess empathy; the resulting empathy scale’s internal consistency in the present study was  $\alpha = .93$ . As described above, from the 16 possible answers two sets of scenario-model-combination were chosen, of which 12 of the subjects rated one, and 14 of the subjects rated the other one (see table 1). The cover story, dilemmas, answers, and adjective lists were all presented in electronic format.

### 3.3 Evaluation Results & Discussion

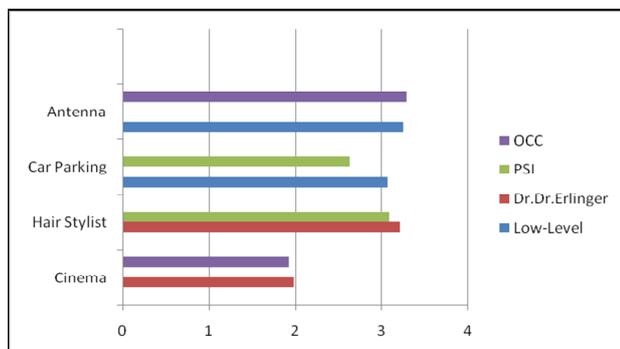
The results of the evaluation suggest that the differences between the scenarios cause differences in the empathy rating, not the underlying model characteristics. A two-way ANOVA yielded a significant main effect for scenario ( $F=43.24$ ;  $df=3$ ;  $p=.000$ ), but neither a significant main effect for model nor an interaction effect. Particularly the answers to the cinema-scenario were rated significantly less empathic than the other answers, independent of the underlying model (see figure 4). Regarding the differences between the models, there are significant differences between the low-level model on the one hand which is rated with the highest empathy scores and the OCC-inspired model and the original answer by Dr. Dr. Erlinger on the other hand which obtain the lowest empathy scores ( $t=2.77$ ;  $p=.008$ ;  $t=-3.47$ ;  $p=.001$ ).

Obviously, while the design tried to carefully minimize variance produced within one scenario through the process of adapting the answers to the model approaches (e.g. by using different words, phrases, varying length of the answer), the variance produced by the differences among the scenarios overruled the subtle differences that were caused by the model adaptations. The scenarios seem to be differentially prone to evoke empathic reactions. While the moral dilemma of the cinema scenario discusses the intrusion of personal space in the situational context of leisure time, the antenna scenario analyses the dangers posed by a radio antenna for mobile phones on the roof of a family home in which a friend plans to raise her small children. Obviously, the latter scenario provides much more potential for emotional involvement than the first. Thus, the results of the present study provide valuable insight into which of the scenarios is more appropriate for empathy research than the others.

However, the main research question could not be answered with the present design due to the fact that (1) the scenarios produce much stronger differences in empathy ratings than the models at stake, and (2) there is no complete set of empathy ratings for all of the four models within one scenario. Definite conclusions about the qualitative difference between the empathic outcome of the models thus have to be addressed by more elaborate data collection, including more subjects and all three (four) competing models within each scenario. In order to reduce the work load for the participants (the main reason for the present design), only one scenario should be used and adapted to the three different models, e.g. “antenna” which seems most appropriate to trigger

empathy according to the present results. Thus, variance between the different scenarios would be controlled for. Furthermore, the approach would benefit from a supplementary validation of the text-based model implementation, e.g. through setting up a small group of trained experts to test whether the empathic “behavior” of the models can be reproduced.

Discussing the (insignificant) differences between the models, the low-level model yielded the highest empathy scores. This might be due to the relatively simple “if-then”-rules which could be easily implemented in the expert answers, providing these answers with an easy-to-read structure that was “rewarded” by the participants of our study. In contrast, the OCC-inspired approach is based on rather complex appraisals resulting in a set of numerous qualitatively different emotional states; only few of these emotional states were applicable to the present scenarios: the complexity of the model was obviously not recognizable for the participants of our study, given the limited character of the “behavior” they had to rate. Dr. Dr. Erlingers on the other hand, who writes the original expert answers in a weekly magazine, does not only provide empathy for the reader who sends in the dilemma, but also wants to entertain his readers, a motivation that might interfere at times with his display of empathy, as opposed to a face-to-face situation between e.g. a client and a consultant or a therapist.



**Figure 4. Empathy scores for models and scenarios.**

In sum, the text-based evaluation yields differences in empathic outcomes, providing insights in the working mechanisms of different theoretical conceptions of empathy. The scenarios clearly differ in their empathic potential, contrasting topics from leisure time with the safety of a family home. However, taking into account the minimal model adaptations made to the answers by keeping all non-emotional content of the originals untouched, this methodology might be of further use in the forefront of programming agents if the model characteristics and differences would be implemented more clearly than in the present study.

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#### 5. REFERENCES

- [1] Paiva, A., Dias, J., Sobral, D., Silva, C., Aylett, R.S., Woods, S. & Zoll, C. 2004. Caring for Agents and Agents that Care: Building Empathic Relations with Synthetic Agents. In Proceedings of the Third International Joint Conference on Autonomous Agents and Multi Agent Systems (AAMAS04).
- [2] Holz-Ebeling, F. & Steinmetz, M. „Wie brauchbar sind die vorliegenden Fragebogen zur Messung von Empathie? Kritische Analyse unter Berücksichtigung der Iteminhalte“, *Zeitschrift für Differentielle und Diagnostische Psychologie* 1995, 16, 11-32.
- [3] Davis, M. H. (1994). *Empathy – a social psychological approach*. Brown & Benchmark Publishers, Madison, Wis.
- [4] Hogan, R. “Development of an empathy scale”, *Journal of Consulting and Clinical Psychology* 1969, 35, 307–316.
- [5] Hoffman, M. L. 1977. Empathy, its development and prosocial implications. In *Nebraska Symposium on Motivation*, vol. 25, C.B. Kaesly, Ed. University of Nebraska Press, Lincoln.
- [6] Dias, J. and Paiva, A. 2005. Feeling and Reasoning: a Computational Model. In *EPIA 2005. LNCS (LNAI)*, vol. 3808, C. Bento, A. Cardoso, G. Dias, Eds. Springer, Heidelberg.
- [7] Dörner, D 2001. *Bauplan für eine Seele*. Rowohlt, Reinbek.
- [8] Dörner, D 2003. The mathematics of emotion. *The Mathematics of Emotions*. In *The Logic of Cognitive Systems – Proceedings of the Fifth International Conference on Cognitive Modeling (ICCM 2003)*, F. Detje, D. Dörner, D. & H. Schaub, Eds. Universitätsverlag, Bamberg.
- [9] *Süddeutsche Magazin*, DOI= <http://sz-magazin.sueddeutsche.de/hefte>.
- [10] Davis, M. H., Luce, C., Kraus, S. J., “The heritability of characteristics associated with dispositional empathy”, *Journal of Personality* 1994, 62, 369-391.
- [11] Hoffman, M. L. 1984. Interaction of affect and cognition in empathy. In *Emotions, cognition, and behavior*, C. Izard, J. Kagan, & R. Zajonc Eds. Cambridge University Press, New York.
- [12] James, W. 1890. *The principles of psychology*. Holt, New York.
- [13] Ickes, W., Stinson, L., Bissonnette, V., & Garcia, S. „Naturalistic social cognition: Empathic accuracy in mixed-sex dyads”, *Journal of Personality & Social Psychology* 1990, 59 (4), 730-742.
- [14] Jones, E. E. & Nisbett, R. E. 1972. The actor and the observer: Divergent perceptions of the causes of the behavior. In *Attribution: Perceiving the causes of behaviour*, E. E. Jones, D. E. Kanouse, H. H. Kelley, R. E. Nisbett, S. Valins & B. Weiner Eds. General Learning Press, Morristown, NJ.

[15] Ortony, A., Clore, G., and Collins, A. 1988. *The cognitive structure of emotions*. University Press, Cambridge.

[16] Newell, A. 1990. *Unified Theories of Cognition*. Harvard, Cambridge, MA.

[17] Anderson, J. R. "Spanning seven orders of magnitude: A challenge for cognitive modelling", *Cognitive Science* 2002, 26, 85-112.

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