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Why Not Artificial Sympathy?

Minoru Asada, Yukie Nagai, and Hisashi Ishihara

Dept. of Adaptive Machine Systems, Graduate School of Engineering
Osaka University
Yamadaoka 2-1, Suita, Osaka, 565-0871, Japan
{asada,yukie,hisashi.ishihara}@ams.eng.osaka-u.ac.jp
http://www.er.ams.eng.osaka-u.ac.jp

Abstract. "Empathy" and "Sympathy" are often confusingly used. Beside the difference in their usage, the key component could be a sort of emotional state to be shared, and the way to represent or manipulate it might be different. This could be clearer when we attempt to design it for artificial agents. This paper argues what are differences between empathy and sympathy, and how to design each of them for an artificial agent. First, the dictionary meaning of both is reviewed, and a metaphor to intuitively explain the difference is introduced. Next, we argue how artificial empathy and artificial sympathy can be designed, and a cognitive developmental robotics is introduced as a promising approach to the latter, especially from a viewpoint of learning and development. A rough design for artificial sympathy is argued, and preliminary studies needed to build the artificial sympathy are introduced. Finally, future issues are given.

1 Introduction

"Empathy" and "Sympathy" are often confusingly used. The Oxford Dictionary of English 3rd edition (2010 by Oxford University Press, Inc.) describes each as follows:

- **empathy:** the ability to understand and share the feelings of another. **ORIGIN:** early 20th cent.: from Greek empatheia (from em-'in' + pathos 'feeling') translating German Einfühlung.
- **sympathy:** feelings of pity and sorrow for someone else's misfortune. **ORIGIN:** late 16th cent. : via Latin from Greek sumpatheia, from sun- 'with' + pathos 'feeling'.

The key component seems a sort of emotional state to be shared, and the way to represent or manipulate it might be different. This aspect can be magnified when we attempt to design it for artificial agents. One metaphor to show the difference is the following story. Medical doctors can infer the distress of their patients (empathy), and they can do adequate operations to reduce the distress of the patients. However, they often face difficulty to do any operations when the patients are their own sons or daughters (sympathy).

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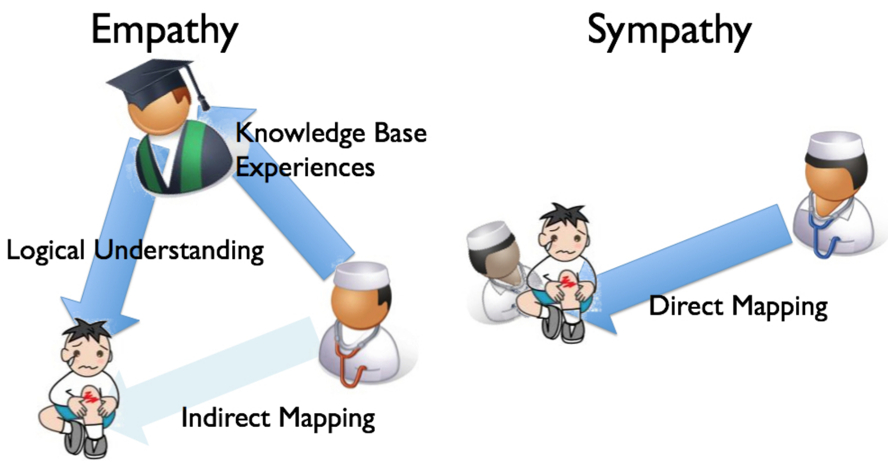

Fig. 1. A metaphor to explain the difference between empathy and sympathy

Figure 1 indicates an intuitive explanation for the difference between empathy and sympathy in this case, and this is our interpretation in this article which we derived from the dictionary meaning above. In the case of empathy, it is supposed to be a kind of indirect mapping from a medical doctor to a patient through a knowledge database including the doctor's own experiences, from where logical inference for the patients (emotional) state is applied to the patient, which is based on the observation from a god's viewpoint (topdown). On the other hand, in the case of sympathy, it is supposed a direct mapping from the doctor's emotional state into the patient's state without the logical process of reasoning to understand the patient's state. The Greek origin of "sym (sun)" means "with," which implies "with the patient" (not topdown, but almost the same level).

Which can be a target when we attempt to build an artificial system that can share the emotional state between a human and a robot? At a glance, the former (empathy) seems more practical for the artificial system to be designed since the machine is good at searching cases similar to the current patient state from a huge amount of data through the net, and applying rules to understand the patient state logically. Therefore, the existing artificial systems have taken this style based on the logical understanding of the situations by coding if-then rules regardless of a real understanding of each emotional state's meaning. On the other hand, the latter is a direct mapping such as an emotional reaction from one's own emotional state to that of another regardless of a logical understating of the other's situation. Can we realize such an artificial system with a different body structure including brain? This article argues about the possibility for artificial empathy and artificial sympaty referring to the existing works and cognitive developmental robotics as a promissing approach to the artificial sympathy.

The rest of the paper is organized as follows. First, how to design artificial empathy or artificial sympathy is argued with pioneering studies. Then, CDR is reviewed from a viewpoint of designing artificial sympathy, and a design plan consisting of three steps is shown as one approach to artificial sympathy and also to other cognitive and affective functions as well. Three steps are physical embodiment, development of self/other cognition, and social interaction. Preliminary studies corresponding to these steps are introduced, and finally, future issues are given.

2 Artificial Empathy and Artifcial Sympathy

There are two pioneering works related to the issue. The first one is about artificial emotion by Prof. Shigeki Sugano's group [1]. They built an an emotional communication robot, WAMOEBA (Waseda-Ameba, Waseda Artificial Mind On Emotion BAse), to study a robot emotional model, especially focusing on the emotional expression during human-robot interaction [12]. The emotional expression is connected to self-preservation based on self-observing systems and hormone parameters they defined.

The second one is a series of studies on emotion expression humanoid robot WE (Waseda Eye), and the recent one is WE-4RII which can show very rich facial and gestural expressions based on sophisticated mechatronics and software (ex., [8,9] [2]). They designed mental dynamics caused by stimuli from the internal and external environment based on a mental model with a kind of instinct (need model).

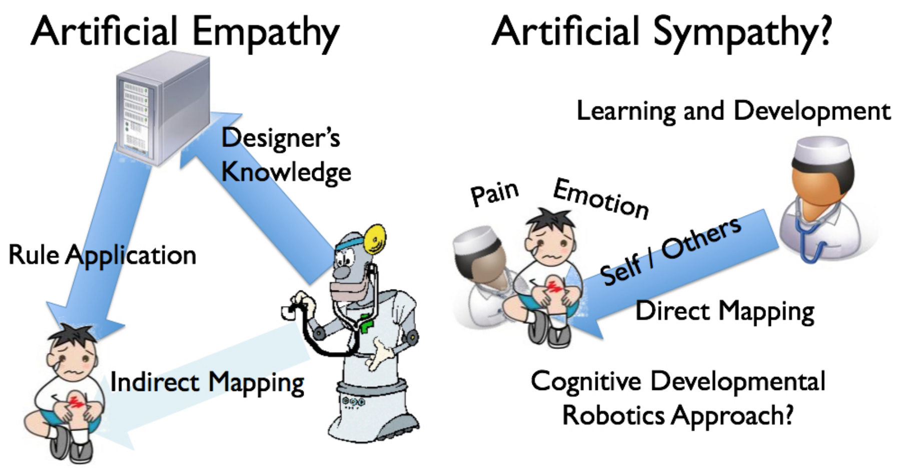

Fig. 2. What are artificial empathy and artificial sympathy?

Both studies are pioneering in respect that emotion is linked to self-preservation or instinct (need model), and that robots are capable to show emotional expressions based on their emotion models. However, it is not clear how a robot can

[1] for the detail, visit `http://www.sugano.mech.waseda.ac.jp`
[2] also visit `http://www.takanishi.mech.waseda.ac.jp/top/research/index.htm`

share an emotional state with humans. Since almost all of the robot behaviors are explicitly specified by the designer, little space is left for robots to learn or develop to share their emotional states. This approach may link to artificial empathy shown in Figure 2 where a huge knowledge database is available to understand (search for the case of) the patient's emotional state. One extreme view is that their approaches resemble the classical AI ones (GOFAI), and therefore seem to have limited capacity to share emotional expressions. In the case of artificial sympathy (if possible), the robot can feel the emotional state of the patient as its own (direct mapping). How can we realize such an artificial sympathy in robots? One simple approach is to minimize the part which the designer explicitly specifies or defines, but, instead, to maximize the room for learning such parts through the interaction with environment including others. This is not specific only to artificial empathy or sympathy, but general in acquiring cognitive and affective functions.

One big trend is cognitive developmental robotics (hereafter, CDR) [2] based on "physical embodiment," "social interaction," and "learning and development." Physical embodiment is a necessary condition for an artificial agent to create its sensation via sensorimotor mapping. Social interaction may help the agent feel its own emotional state and develop its emotional states to be social (caregiver's scaffolding). CDR is expected not only to realize artificial sympathy adaptive to new situations owing to the capability of learning and development of robots, but also to shed light on understanding empathy and sympathy from a viewpoint of design theory.

3 Cognitive Developmental Robotics as a Constructivist Approach

Roughly speaking, the developmental process consists of two phases: individual development at an early stage and social development through interaction between individuals at a later stage. The former relates mainly to neuroscience (internal mechanism), and the latter to cognitive science and developmental psychology (behavior observation). Intrinsically, both should be seamless, but there is a big difference between them at the representation level as a research target to be understood. CDR aims not at simply filling the gap between them but, more challengingly, at building a new paradigm that provides new understanding of ourselves while at the same time adding a new design theory of humanoids that are symbiotic with us. The following is a summary:

A: construction of a computational model of cognitive development
1. hypothesis generation: proposal of a computational model or hypothesis based on knowledge from existing disciplines
2. computer simulation: simulation of the process difficult to implement with real robots such as physical body growth
3. hypothesis verification with real agents (humans, animals, and robots), then go to 1)

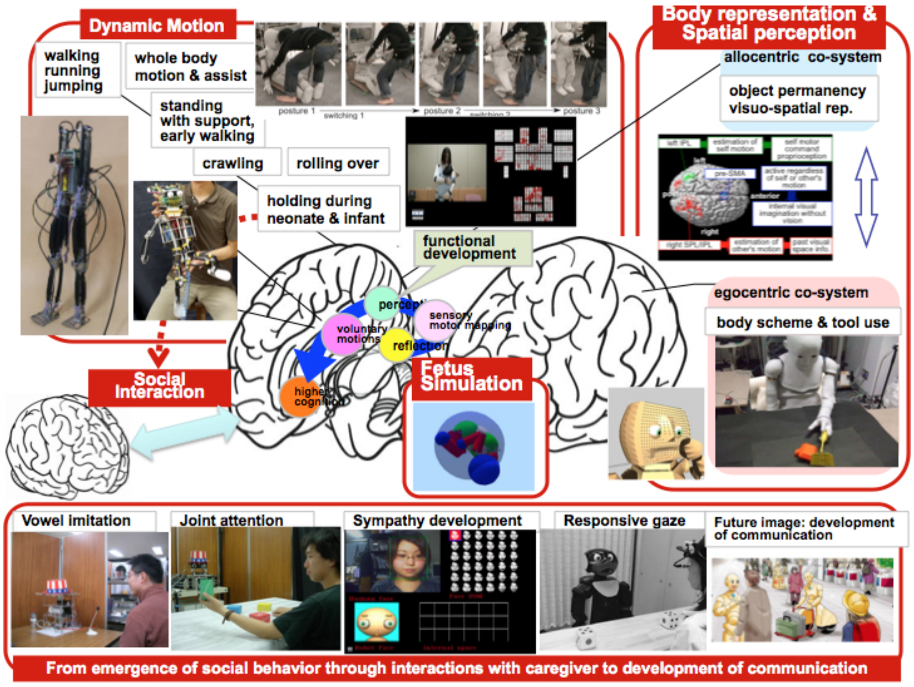

Fig. 3. A Cognitive Developmental Map (Adopted from Fig.3 in [2])

B: offer new means or data to better understand the human developmental process → mutual feedback with A
1. measurement of brain activity by imaging methods
2. verification using human subjects or animals
3. providing the robot as a reliable reproduction tool in (psychological) experiments

The survey [2] introduces many studies by CDR.

3.1 A Cognitive Developmental Map

Let us consider a cognitive developmental map based on various aspects. The major functional structure of the human brain-spine system is a hierarchical one reflecting the evolutionary process, and consists of spine, brain stem, diencephalon, cerebellum, limbic system, basal ganglia, and neocortex. Here, we regard this hierarchy as the first approximation toward the cognitive developmental map, and the flow of functional development is indicated at the center of Fig. 3, that is, reflex, sensorimotor mapping, perception, voluntary motion, and higher-order cognition.

In Fig. 3, we show, as much as possible, correspondences between developmental processes for individuals and the relationship between objects and individuals to brain regions in terms of functions. Among these regions, the medial frontal cortex (hereafter, MFC) is supposed to be closely related to mind development and social cognition [1]. However, it seems that a more global network of the brain works together for such development and cognition, and more importantly, that the interaction triggered by caregivers (scaffolding) is one of the environmental factors that plays an essential role in various developmental processes, such as vocal imitation ([17,5]), joint attention ([14,15]), and also sympathy development.

3.2 Development of Sympathy

Here, we focus on the development of sympathy in respect to physical embodiment, social interaction, and development, together.

- **Physical Embodiment:** As a necessary item for robots to have artificial sympathy, they have to have a physical body to perceive the other's emotional state and to generate emotional behavior responding to the perceived one. WE-4RII is an excellent platform to show its emotional expressions, but we need a developmental process of facial and gestural expressions (learning of muscle control for corresponding expressions) that may enhance the capability to generate new emotional expressions and to be adaptive to unexpected situations.
- **Development of Self/Other Cognition:** before being able to share the emotional state between a human and a robot, it has to have a concept of self and others, first. This is one of the big issues in human cognitive development in general, not specific to the development of sympathy. However, this seems essential to consider in the development of artificial sympathy by which the emotional state of others can be regarded as its own. The Mirror system is expected to extend such emotion sharing although we should be careful not to have undue expectations of the MNS [4]. In any case, we need a developmental process for self/other discrimination which might be a fundamental structure for artificial sympathy.
- **Social Interaction:** another essential aspect of artificial sympathy is social interaction. It is actually the real situation where a human and a robot share an emotional state with each other, and more importantly, it is the situation where artificial sympathy develops. A typical situation is infant-caregiver interaction where the caregiver shows various kinds of voluntary/involuntary teaching such as motherese [7] and motionese [10]. In the case of sympathy, what kind of teaching promotes the development of emotion sharing?

In the following, we show preliminary studies toward the artificial sympathy.

4 Preliminary Studies by CDR

4.1 Affetto, A Little Child Robot for Interaction Study [6]

WE-4RII shows rich emotional expressions with sophisticated mechatoronics, and the emotional states perceived by humans could be realistic ones. However,

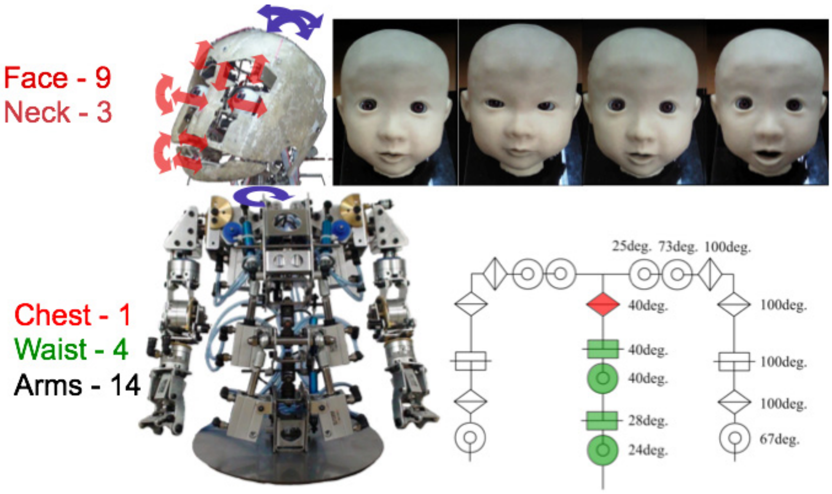

Fig. 4. Affetto head with the internal structure of the upper torso

humans understand them not as real ones. In order to study emotional interaction between an infant and its caregiver, we may need much more realistic baby robots. For that purpose, we are building such a face robot, Affetto, that has the realistic appearance of a 1- to 2-year-old child. Fig. 4 shows a prototype of Affetto built in our laboratory.

Currently, Affetto is supposed to be a platform for interaction study as a controllable baby by which systematic experiments can be done. In the future, we will embed a learning structure for artificial sympathy into Affetto, and will have more dynamic experiments of Affetto and caregiver interactions.

4.2 An Early Developmental Model for Self/Other Cognition [11]

We have proposed a computational model for the early development of the self/other cognition system, which originates from immature vision. The model gradually increases the spatiotemporal resolution of a robot's vision while the robot learns sensorimotor mapping through primal interactions with others. In the early stage of development, the robot interprets all observed actions as equivalent due to lower visual resolution, and thus associates the non-differentiated observation with motor commands. As vision develops, the robot starts discriminating actions generated by itself from those by others. The initially acquired association is, however, maintained through development, which results in two types of associations: one is between motor commands and self-observation and the other between motor commands and other-observation. Our experiments demonstrate that the model achieves early development of the self/other cognition system, which enables a robot to imitate others' actions.

Figure 5 shows a model for emergence of the self/other cognition system originating from immature vision. We expect this kind of developmental system can be applied to the process of sympathy development, as well.

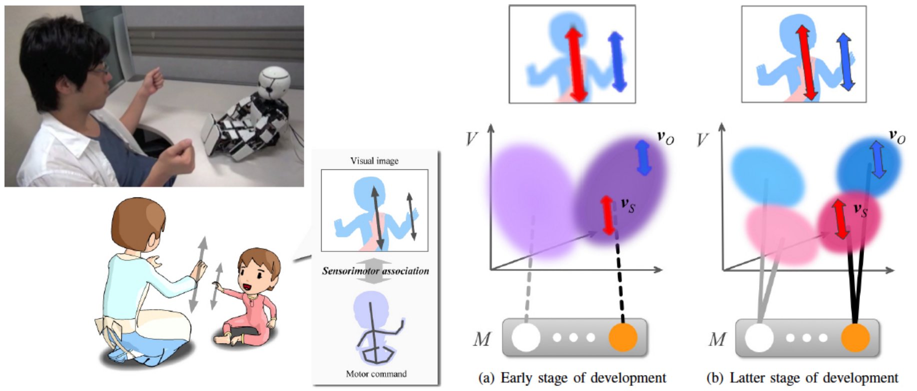

Fig. 5. A model for emergence of the self/other cognition system originated in immature vision

4.3 Finding Correspondence between Facial Expressions and Internal States [16]

From a viewpoint of social interaction, the question was what kind of caregiver's behavior lead the developmental process of infant sympathy. In developmental psychology, intuitive parenting is regarded as the maternal scaffolding upon which children develop sympathy when caregivers mimic or exaggerate the child's emotional facial expressions [3]. We model human intuitive parenting using a robot that associates a caregiver's mimicked or exaggerated facial expressions with the robot's internal state to learn a sympathetic response. The internal state space and facial expressions are defined using psychological studies and change dynamically in response to external stimuli. After learning, the robot responds to the caregiver's internal state by observing human facial expressions. The robot then expresses its own internal state facially if synchronization evokes a response to the caregiver's internal state.

Fig. 6 (left) shows a learning model for a child developing a sense of sympathy through the intuitive parenting of its caregiver. When a child undergoes an emotional experience and expresses its feelings by changing its facial expression, the caregiver sympathizes with the child and shows a concomitantly exaggerated facial expression. The child then discovers the relationship between the emotion experienced and the caregiver's facial expression and comes to mutually associate the emotion and the facial expression. The emotion space in this figure is constructed based on the model proposed by Russell [13].

5 Future Issues

In this paper, we enhanced the difference between empathy and sympathy from a viewpoint of design theory, and pointed out that the design of artificial sympathy is a big challenge to reconsider the meaning of both and their differences, further

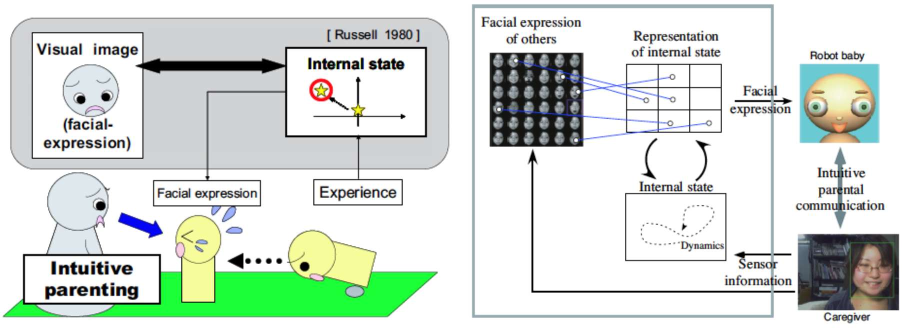

Fig. 6. Learning model for developing sympathy in children through intuitive parenting (left), and associating visual facial expressions of others with internal states (right)

to build such an artificial agent that might have an artificial mind. Future issues are (1) to integrate the mapping of facial expression to internal state and the early development model of the self/other cognition system into Affetto to check any possibility of artificial sympathy after self/other cognition, and (2) more challengingly, to form the concept of "pain," not simply as sensory information acceptance, but as realization of its meaning that recall a deeper understanding of our pain itself.

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