Discourse Particles and User Characteristics in Naturalistic Human-Computer Interaction

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Abstract. In human-human interaction (HHI) the behaviour of the speaker is amongst others characterised by semantic and prosodic cues. These short feedback signals minimally communicate certain dialogue functions such as attention, understanding or other attitudinal reactions. Human-computer interaction (HCI) systems have failed to note and respond to these details so far, resulting in users trying to cope with and adapt to the machines behaviour. In order to enhance HCI, an adaptation to the user's behaviour, individual skills, and the integration of a general human behaviour understanding is indispensable. Another issue is the question if the usage of feedback signals is influenced by the user's individuality. In this paper, we investigate the influence of specific feedback signals, known as discourse particles (DPs), with communication style and psychological characteristics within a naturalistic HCI. This investigation showed that there is a significant difference in the usage of DPs for users of certain user characteristics.

Keywords: human-machine-interaction, discourse particles, personality, user characteristics.

1 Introduction

Verbal human to human communication consists of several information layers, going beyond the pure textual information and transmitting relevant information such as self-revelation, relationship and appeal [31]. These details are normally provided by humans to enhance human-human interaction (HHI) and to increase the likelihood of a positive interaction outcome. Human-computer interaction (HCI) systems have failed to note and respond to these details so far, resulting in users trying to cope with and adapt to the machines behaviour [25]. This adaptation of the user leads to the typical machine-like interaction patterns resulting in a loss of information and lowering the chance of a successful HCI. To obtain a more human-like and more successful interaction with technical systems, those have to be adaptable to the users' individual skills, preferences, and user characteristics. This includes

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both, the ability to understand the user's capabilities and a proper reaction towards him [35].

In HHI the behaviour of the speaker is characterised by semantic and prosodic cues, given as short feedback signals. These so-called discourse particles (DPs) e.g. "hm" or "uhm" minimally communicate certain dialogue functions such as attention, understanding, or other attitudinal reactions. Thus, these signals play an important role in the progress and coordination of the interaction. They allow the conversational partners to inform each other of their behavioural or affective state without interrupting the ongoing dialogue. As a further advantage, these feedback signals can be easily inferred from the speaker's intonation, which is in the case of DPs not influenced by semantic and grammatical information [27].

Two previous studies investigated necessary prerequisites. The first study investigated the occurrence of DPs within HCI and the relation between DPs and predefined pitch contours [29]. Furthermore, the DPs served as features for complex emotion detection [28]. More information about the meaning of DPs can be found in [5,27]. Our previous work investigated the correlation of DP-usage with different age and gender groups. Thereby, we revealed that the variations within the different groups are quite substantial. This indicates that there must be other factors influencing the individual use of DPs. This paper now investigates the correlation of DP-usage and specific psychological characteristics of the subjects within a naturalistic HCI.

1.1 Discourse Particles in HCI

During HHI several semantic and prosodic cues are exchanged among the interaction partners and used to signalize the progress of the dialogue [1]. The intonation of feedback signals transmits the communicative relation of the speakers and their attitude towards the current dialogue. The occurrence of different intonation-meaning relations are depending on the conversation type. In conversations of narrative or cooperative character confirmation signals are dominating, whereas turn holding signals dominate argumentative conversations [24].

As intonation is influenced by semantic and grammatical information, it is advisable to investigate the intonation of so-called DPs [1]. These speech fragments cannot be inflected, but emphasised. The incorporation of DPs in HCI systems will allow a detection of crucial points within the dialogue and help to initiate proper system reactions. Furthermore DPs are uttered in situations of a higher cognitive load [5].

As DPs have a specific function within the conversation (indicate thinking, conformation or request to respond, cf. [27]), the use of these particles requires the conversational partners to understand the meaning. Hence, it may be assumable that DPs do not occur in HCI. The investigation in [10] showed that while the number of partner-oriented signals are decreasing during HCI, the number of signals indicating a task-oriented, or expressive function are increasing. These findings could be confirmed with our previous study, cf. [29].

The so far presented studies demonstrated that DPs are used within HCI [10] and also tried to explain the broad variety of occurrences between different

users [29]. The utilized distribution in young vs. elder users and male vs. female speakers revealed that elderly female speakers using DPs twice as often than elderly male speakers. But the mean variation within the different groups is still quite large. Thus, we assume that other factors influence the use of DPs.

1.2 User Characteristics in HCI

Research on communication and personality dispositions has a distinguished history. Today, it is agreed that personality is a rather complex entity containing different aspects. Thus, many user characteristics are discussed having an influence on the interaction towards technical system. Among others, these variables cover personality traits (attributional style, anxiety, problem solving), which are important for the user's behaviour in both HHI and HCI [8].

In personality psychology and psychological research the "Big Five" factors of human personality were widely confirmed and represent the most influential personality model nowadays [18,23]. Furthermore, the "Big Five"-model had a great impact on research about a certain sequence in natural communication: the initial dyad. Initial dyadic interaction refers to the first contact between humans, i.e., the situation in which two people get to know each other for the first time. A lot of researchers report on strong relations between factors of personality and the communication with another person in this certain situation. In contrast to the "Big Five" model, other theories of personality focuses more on interpersonal relationships. The author in [30] opposed his inter-psychic model to predominant intra-psychic models of personality .

Personality plays an important role in HCI, too (e.g., [7,12]). Former research identified personality traits as well as interpersonal relationship as relevant aspects in the field of HCI [33]. Summarising, there is some evidence suggesting that Extroversion is related to computer aptitude and achievement [32].

In addition, also socio-demographic aspects as age and gender, or affinity to information and communications technology (ICT) are discussed to play an important role [13,19,21]. In the case of ICT-aspects especially the knowledge and skills as well as the anxiety in dealing with technical systems, the user's problem-solving behavior, and thus the whole work style is seen to have an impact [2,3,4]. Furthermore, the user's domain knowledge, and language skills are pointed out in this context [22]. Until now, however, only a few empirical studies investigate the impact of user properties to interaction with a technical system, cf. [22].

2 Dataset

The conducted study utilizes the LAST MINUTE corpus (cf. [25]) as naturalistic HCI database that is already object of examination regarding affective state recognition [11] and linguistic turns [26]. The utilized corpus contains 133 multimodal recordings of German speaking subjects during Wizard-of-Oz (WOZ) experiments. The setup revolves around a journey to the unknown place "Waiuku",

which the subjects have won. Each experiment takes about 30 minutes. Using voice commands, the subjects have to prepare the journey, pack the suitcase, and select clothing. Most of the experiments are transliterated, enabling the automatic extraction of speaker utterances. Details can be found in [25].

The experiment is distinguished into two modules, with two different dialogue styles: personalisation and problem solving module [25]. The personalisation module, being the first part of the experiment, has the purpose of making the user familiar with the system and to make his behaviour more natural. In this introduction (IN) the users are encouraged to talk freely. We furthermore located the same dialogue style at the end of each experiment, when the system asks further questions about the satisfaction with the user's solution and denote this as closure (CL).

During the problem solving module the user is expected to pack the suitcase for his journey. The dialogue follows a specific structure of specific user-action and system-confirmation dialogues. This conversation is task focused and the subjects talk more command-like. Thus this part or the experiment has a much more regularized dialogue style. The sequence of these repetitive dialogues is interrupted by pre-defined barriers (Bx) for all users at specific time points. These barriers are intended to increase the stress level of the users.

B1 the task is introduced, no details about commands and target location
B2 the user gets familiar with the system, first excitement gone
B3 the content of the current suitcase is listed verbally
B4 the system refuses to pack items because the weight limit is reached
B5 details about the target location are given
B6 user can repack items but with time pressure

In addition to the WOZ experiment itself, socio-biography and psychometric parameters are collected using validated questionnaires. Psychological questionnaires are established methods for the collection of specific variables. They can thus be used, to determine social and political characteristics, opinions, interests, or psychological characteristics such as personality factors, attributional style, motivation, and many different constructs.

The NEO-FFI [6] is designed to assess the constellation of traits defined by the Five Factor theory of personality. The model assumes that behaviour in situations (state) is influenced by steady characters (traits). The "Big Five" factors are extroversion, agreeableness, conscientiousness, neuroticism, and openness.

Another questionnaire utilizes Sullivan's model of personality and focuses on interpersonal relationships. The inventory of interpersonal problems (IIP) [14] is a model for conceptualizing, organizing, and assessing interpersonal behaviour, traits, and motives. Eight scales mark the interpersonal circumplex by selecting items (domineering, vindictive, cold, socially avoidant, nonassertive, exploitable, overly nurturant and intrusive). As the experiment is conducted with German speaking subjects, the German version is used, cf. [15].

The stress-coping questionnaire (SVF) [17] includes 20 scales (e.g. deviation, self-affirmation, control of reaction) for different types of response to an unspecific

selection of situations that impair, adversely affect, irritate, or disturb the emotional stability or balance of the subject.

Additionally to this psychometric instruments socio-demographic variables like age, gender, educational level, experience with computers (e.g. years overall, hours per day/week), and in what context the subjects use the computer are collected. This corpus is designed to have an equal distribution of gender and age of the subjects. The younger group ranges from 18-28 years. the elder group consists of subjects being over 60 years.

3 Results

We used a subset of 89 subjects with a total duration of approx. 45 hours. The group distribution of age and gender is as follows: 21 young male and 23 young female subjects and 19 old male and 27 old female subjects. As the experiment is transliterated, we conducted an automatic alignment with a manual correction phase for the DP-extraction. Within our subset of 89 subjects, only 3 subjects do not utter any DP. The overall number of DPs is 1975, the mean is 28.77 particles per conversation with a standard deviation of 25.15. One subject uses 107 particles in an experiment, which is the maximum. To analyse the DP-usage, we set the DPs in relation to the total number of user's acoustic utterances of any kind like words, see Fig. 1. As statistical test, we use a one-way ANOVA, to compare means of our two mean-splitted samples, cf. [16].

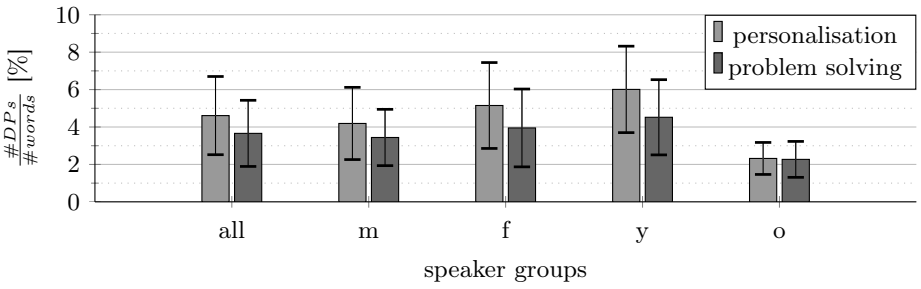

Fig. 1. Mean and standard deviation for the DPs divided into the two dialogue styles regarding different speaker groups in the case of gender (male, female) and age (young and old). For comparison the group independent frequency (all) is given, too.

We further notice, that the usage of DPs is not equally distributed among the gender and the age of the subjects, see Fig. 1. This difference is largely determined by the speaker's age. The difference between the young and old speakers is significant for both personalization ($p < 0.002$) and problem solving ($p < 0.027$). This means that young and old users do not only different by their age, but also in relation to the type of communication (personalization or

problem solving). Hereby the group differences are from special interest, while the usage of DPs for elderly does not reveal big differences in the both phases, young users on the other hand have distinct differences between personalisation and problem solving. Regarding the other groups, only substantial differences can be noticed, this may be mostly due to the small sampling size.

From this investigations, it can be seen that the standard deviation is quite high. This indicates a high individuality of the users' DP-usage and we assume that additional criteria, as specific psychological characteristics, are inferring the usage of DPs. Therefore, we further analyse the DP-usage depending on specific user characteristics. Hereby, we again set the DPs in relation to the total number of user's acoustic utterances. of user's acoustic utterances. We furthermore differentiate between user traitsbelow the mean (low trait) and those at or above the mean (high trait). As statistical test, we use a one-way ANOVA, to compare means of our two mean-splitted samples, cf. [16]. The results can be found in Fig. 2. We only depict results with provide substantial results nearly the significance.

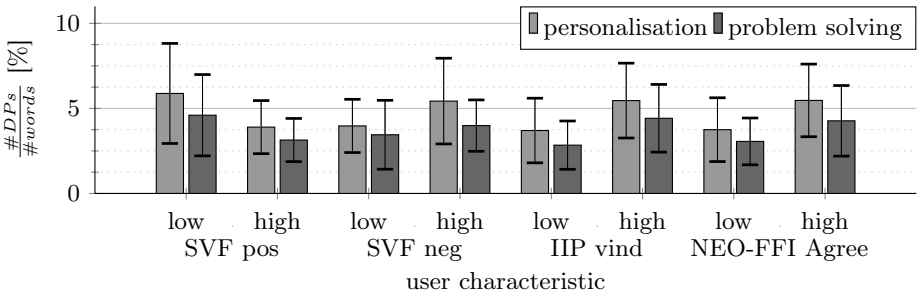

Fig. 2. Mean and standard deviation for the DPs divided into the two dialogue styles regarding different groups of user characteristics

Considering the psychological characteristics, no significant differences are noticeable on the distinction between the two dialogue styles personalisation and problem solving. This is mostly due the fact, that we compare very few users within a very heterogeneous sample.

As the influence of psychological characteristic heavily depends on the situation in which the user is located. The distinction in a free dialogue and regulated dialogue may not be sufficient to describe the user's situation. Especially in the regulated problem solving module very different situations are induced by the experimental design, which also produce partly contradictory user reactions. But to make at least substantial statements, the number of samples is not sufficient, as stated before.

For interpreting the SVF positive strategies distraction (SVF pos), we could state that subjects having better skills in stress management with regard to positive distraction use substantial less DPs. Especially in the personalization they

showed less DPs. The finding on SVF negative strategies (SVF neg) confirms the previous one. Subjects who do not have a good stress management and unlike even have negative stress management mechanisms (i.e. stress management mechanisms increasing the stress) also use more DPs.

Evaluating the IIP personality trait vindictive competing (IIP vind), we can state that subjects using DPs more frequently, Volunteers, more likely to have problems trusting others or rather towards others are suspicious and are rather quarrelsome showed more DPs.

Also the interpretation of the NEO-FFI confirms the IIP-findings because the subjects having less DPs show less confidence in dealing with other people.

Thus, it can be assumed that the usage of DPs is accompanied by "negative" psychological characteristics. This supports the findings that DPs are uttered in situations of a higher cognitive load [5].

4 Discussion

Th presented investigation on the use of specific back-channel signals in HCI and their correlation with psychological characteristics allows us to investigate HCI from a new perspective. First, the verified use of DPs in HCI prove the assumption that HCI and HHI are comparable, which has long been presupposed for investigating HCI, cf. [9,34]. Our investigation furthermore indicates that humans tend to use mechanisms from HHI they are familiar with also when interacting with technical systems, although they are aware that these systems do not have the same capabilities than human conversational partners [20].

The precise analysis of DP-occurrence within the dialogue styles reveals that the use of DPs is more likely when the subject is encouraged to talk freely than during structured dialogues. Furthermore, the age of the speakers influenced the usage of DPs, when taking the verbalisation into account. IN our analysis young and old users do not only different by their age, but also in relation to the type of communication (personalization or problem solving). This could be interpreted that young users are more confident when using a machine-like interaction than elderly users. Anyway, young users seem to be familiar with this kind of conversation.

Other factors that influence the usage of DPs are the user's psychological characteristics. Hereby our investigations reveal that the usage of DPs corresponds with specific psychological characteristics that describe the user's interpersonal relationship, attributional style, and technological affinity.

Our investigations reveal that the occurrences of DPs could provide hints of specific psychological characteristics in pre-known situations of the interaction. Especially in situations of a higher cognitive load [5], when the user is not able to deal with this "negativity".Thus, if these characteristics are already known, than the usage of DPs can be seen as stress indicators, which have to be taken into account for an appropriate reaction of the system.

For appropriate reactions, the system should also take into account the different communicative functions the DPs have, cf. [28]. This investigation indicates

that technical system can be enabled to easily differentiate the DP-intonation of "thinking". In cases where the user utters a DP having this meaning, the system should wait for the user input, in cases of a more competent user in dealing with technical systems. In contrast, only for users do not having this competence, the system should offer explanations.

5 Conclusion

Our investigations show that DPs are also utilized within a HCI, although, the users know that these feedback signals cannot be interpreted by the technical system. However, it should be noted that one can not draw certain conclusions from the purely presence of DPs. The revealed age-bias as well as psychological characteristics have to be taken into account, especially if the interaction makes certain demands on the user, as higher problem solving abilities or specific language skills. It has also been shown that the current situation in which the user with its specific psychological characteristic is located has a significant impact on the use of DPs.

However, it remains to be clarified to what extent such studies can be transferred to other corpora and other situative interactions. This includes an in-depth study of the used DP-functions with respect to the experimental situation and psychological characteristics. Unfortunately, for this purpose the number of DPs in actual material is too low.

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References

1. Allwood, J., Nivre, J., Ahlsn, E.: On the semantics and pragmatics of linguistic feedback. Journal of Semantics 9(1), 1–26 (1992)
2. Anderson, A.A.: Predictors of computer anxiety and performance in information systems. Computers in Human Behavior 12(1), 61–77 (1996)
3. Beckers, J.J., Rikers, R.M., Schmidt, H.G.: The influence of computer anxiety on experienced computer users while performing complex computer tasks. Computers in Human Behavior 22(3), 456–466 (2006)
4. Ceyhan, E.: Computer anxiety of teacher trainees in the framework of personality variables. Computers in Human Behavior 22(2), 207–220 (2006)
5. Corley, M., Stewart, O.W.: Hesitation Disfluencies in Spontaneous Speech: The Meaning of *um*. Language and Linguistics Compass 2, 589–602 (2008)
6. Costa, P., McCrae, R.: NEO-PI-R Professional manual. Revised NEO Personality Inventory (NEO-PI-R) and NEO Five Factor Inventory (NEO-FFI). Psychological Assessment Resources, Odessa (1992)

7. Cuperman, R., Ickes, W.: Big five predictors of behavior and perceptions in initial dyadic interactions: Personality similarity helps extraverts and introverts, but hurts disagreeables. J. Pers. Soc. Psychol. 97(4), 667–684 (2009)
8. Daily, J.: Personality and Interpersonal Communication. In: Handbook of Interpersonal Communication, pp. 133–180. Sage, Thousand Oaks (2002)
9. Elliot, C.: The application of pragmatics in Human-Computer interaction. Ph.D. thesis, Sheffield Hallam University (1993)
10. Fischer, K., Wrede, B., Brindöpke, C., Johanntokrax, M.: Quantitative und funktionale Analysen von Diskurspartikeln im Computer Talk. International Journal for Language Data Processing 20(1-2), 85–100 (1996)
11. Frommer, J., Michaelis, B., Rsner, D., Wendemuth, A., Friesen, R., Haase, M., Kunze, M., Andrich, R., Lange, J., Panning, A., Siegert, I.: Towards Emotion and Affect Detection in the Multimodal LAST MINUTE Corpus. In: Proc. of the Eight LREC 2012, ELRA, Istanbul (May 2012)
12. Funder, D.C., Sneed, C.D.: Behavioral manifestations of personality: An ecological approach to judgmental accuracy. J. Pers. Soc. Psychol. 64(3), 479–490 (1993)
13. Hermann, F., Niedermann, I., Peissner, M., Henke, K., Naumann, A.: Users interact differently: Towards a usability- oriented user taxonomy. In: Jacko, J.A. (ed.) HCI 2007. LNCS, vol. 4550, pp. 812–817. Springer, Heidelberg (2007)
14. Horowitz, L., Alden, L., Wiggins, J., Pincus A.: Inventory of Interpersonal Problems Manual. The Psychological Corporation, Odessa (2000)
15. Horowitz, L., Strau, B., Kordy, H.: Inventar zur Erfassung Interpersonaler Probleme (IIPD) (Inventory of interpersonal problems-German version), 2nd edn. Beltz, Weinheim (2000)
16. Howell, D.: Statistical Methods for Psychology, 7th edn. Cengage Learning (2009)
17. Jahnke, W., Erdmann, G., Kallus, K.: Stressverarbeitungsfragebogen mit SVF 120 und SVF 78, 3rd edn. Hogrefe, Göttingen (2002)
18. John, O., Hampson, S., Goldberg, L.: Is there a basic level of personality description? J. Pers. Soc. Psychol. 60(3), 348–361 (1991)
19. King, J., Bond, T., Blandford, S.: An investigation of computer anxiety by gender and grade. Computers in Human Behavior 18(1), 69–84 (2002)
20. Lange, J., Frommer, J.: Subjektives Erleben und intentionale Einstellung in Interviews zur Nutzer-Companion-Interaktion (Subjective experience and intentional setting within intervies of User-Companion-Interaction). In: Informatik 2011: Informatik schafft Communities, Beitrge der 41. Jahrestagung der GI. Lecture Notes in Informatics, vol. 192, pp. 240–254 (2011)
21. Lithari, C., Frantzidis, C., Papadelis, C., Vivas, A., Klados, M., Kourtidou-Papadeli, C., Pappas, C., Ioannides, A., Bamidis, P.: Are females more responsive to emotional stimuli? A neurophysiological study across arousal and valence dimensions. Brain Topography 23(1), 27–40 (2010)
22. Naumann, A., Hermann, F., Peissner, M., Henke, K.: Interaktion mit Informations- und Kommunikationstechnologie: Eine Klassifikation von Benutzertypen (Interaction with information and communication technology: A classification of user types). In: Herczeg, M., Kindsmller, M.C. (eds.) Mensch und Computer 2008: Viel Mehr Interaktion, pp. 37–45. Oldenbourg Verlag, München (2008)
23. Ozer, D.J., Benet-Martinez, V.: Personality and the prediction of consequential outcomes. Annu. Rev. Psychol. 57(3), 401–421 (2006)
24. Paschen, H.: Die Funktion der Diskurspartikel HM (The function of discourse particles HM). Master's thesis, University Mainz (1995)

25. Prylipko, D., Rösner, D., Siegert, I., Günther, S., Friesen, R., Haase, M., Vlasenko, B., Wendemuth, A.: Analysis of significant dialog events in realistic human computer interaction. Journal on Multimodal User Interfaces (2013)
26. Rösner, D., Kunze, M., Otto, M., Frommer, J.: Linguistic analyses of the LAST MINUTE corpus. In: Jancsary, J. (ed.) Proceedings of KONVENS 2012, pp. 145–154. oral presentations, Main track (2012)
27. Schmidt, J.E.: Bausteine der Intonation (Components of intonation). In: Neue Wege der Intonationsforschung, Germanistische Linguistik, vol. 157-158, pp. 9–32. Georg Olms Verlag, Hildesheim (2001)
28. Siegert, I., Hartmann, K., Philippou-Hübner, D., Wendemuth, A.: Human Behaviour in HCI: Complex Emotion Detection through Sparse Speech Features. In: Salah, A.A., Hung, H., Aran, O., Gunes, H. (eds.) HBU 2013. LNCS, vol. 8212, pp. 246–257. Springer, Heidelberg (2013)
29. Siegert, I., Prylipko, D., Hartmann, K., Böck, R., Wendemuth, A.: Investigating the form-function-relation of the discourse particle "hm" in a naturalistic human-computer interaction. In: Bassis, S., Esposito, A., Morabito, F.C. (eds.) Recent Advances of Neural Network Models and Applications, Smart Innovation, Systems and Technologies, vol. 26, pp. 387–394. Springer (2014)
30. Sullivan, H.: The interpersonal theory of psychiatry. Norton, New York (1953)
31. von Thun, F.S.: Miteinander reden 1 – Störungen und Klärungen. Allgemeine Psychologie der Kommunikation (Talking to Each Other 1 - faults and clarifications. General Psychology of Communication). Rowohlt, Reinbek (1981)
32. Van der Veer, G.C., Tauber, M.J., Waem, Y., Van Muylwijk, B.: On the interaction between system and user characteristics. Behaviour & Information Technology 4(4), 289–308 (1985)
33. Weinberg, G.M.: The psychology of computer programming. Van Nostrand Reinhold, New York (1971)
34. Weiss, A., Mirnig, N., Buchner, R., Förster, F., Tscheligi, M.: Transferring human-human interaction studies to HRI scenarios in public space. In: Campos, P., Graham, N., Jorge, J., Nunes, N., Palanque, P., Winckler, M. (eds.) INTERACT 2011, Part II. LNCS, vol. 6947, pp. 230–247. Springer, Heidelberg (2011)
35. Wendemuth, A., Biundo, S.: A Companion Technology for Cognitive Technical Systems. In: Esposito, A., Esposito, A.M., Vinciarelli, A., Hoffmann, R., Müller, V.C. (eds.) COST 2102. LNCS, vol. 7403, pp. 89–103. Springer, Heidelberg (2012)